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A New Anole (Reptilia: Squamata) from Chiapas, Mexico

By HOBART M. SMITH

Among specimens recently acquired by the University of Illinois is an adult example of a species of which only a single hatchling has previously been available. The second specimen provides essential evidence of the distinctness of the species it represents from all others at present known. It is appropriately named.

Anolis matudai sp. nov.

Holotype. Univ. Ill. Mus. Nat. Hist, No. 34199, a mature male from "Region de Soconusco," Chiapas, collected by Eizi Matuda, 1944-1949. *Paratype.* U. S. Nat. Mus. No. 137289, a very small juvenile from Finca La Esperanza, Chiapas, collected by Rozella B. and Hobart M. Smith, April 16, 1940.

Diagnosis. A member of the *heteropholidotus* group, having smooth ventrals, and scales between supraorbital semicircles at orbital level in two rows and larger than scales of semicircles. Distinguished from other species of the group by having relatively large ventrals, large limb scales, no enlarged postanals, and no irregularity of body scales.

Description of holotype. Head scales unicarinate; internasal scales rather small, six between nasals; latter in contact with rostral; four postrostrals between nasals; 7 canthals in a straight line between superciliaries and anterior supralabial; 8 scales between posterior canthals; frontal depression distinct, with moderately large scales; scales of supraorbital semicircles smaller than those between; latter in two rows; three rows of scales between interparietal and semicircles; interparietal scarcely smaller than adjacent scales, much smaller than ear opening; 8 or 9 enlarged supraoculars, about size of scales in semicircles; a single row of small scales between semicircles and enlarged supraoculars; 5 rows between supraoculars and superciliaries; 6-7 rows of loreals, upper scales scarcely smaller than others; 7 supralabials to below middle of eye; suboculars completely separated from supralabials; sublabials moderately enlarged; 5 scales in contact with mental between infralabials.

Dorsal scales keeled, much larger than laterals, about 30 across back just in front of groin level, clearly larger than laterals, blending gradually with laterals, gradually increasing in size medially, 16 to one-half head length (6.4 mm.); ventrals about same size as largest dorsals, 16 to one-half head length, quite smooth, flat, not convex.

Caudals keeled except immediately behind anus; middorsal caudals scarcely larger than laterals; whorls poorly defined; no enlarged postanals.

Humerals and antebrachials subequal, about twice size of largest dorsals on body, subequal to largest scales on hind legs; pads rather poorly developed; 15 scales under 2nd and 3rd phalanges (counting distally) of 4th toe; a shallow axillary pocket.

Color in alcohol a dull brownish olive, without markings.

Snout to vent, 41.5 mm.; tail broken; snout to rear of tympanum 12.8 mm.; width of head 8 mm.; hind leg 37 mm.; tibia 11 mm.; tympanum 1.0 mm. x 1.5 mm.

Variation. The paratype is so tiny (23.5 mm. snout-vent) that definite allocation with the holotype is questionable. The differences are seemingly either allometric or subject to individual variation, and accordingly I believe the allocation with the holotype will prove correct, but only further specimens can reveal the inaccuracy of the supposition. The ventral scales are quite large, as is uniquely characteristic of this species in this group (16 to one-half head length), but the dorsals are too small (21 to one-half head length) as compared with the type; the scales of the supraorbital semicircles are slightly larger than the scales between although the general arrangement of scales is the same as in the holotype; the interparietal is larger than adjacent scales and larger than the ear opening; the supralabials and suboculars are narrowly in contact at one rear point; the nasal is separated from the rostral; there are 7 post-rostrals between supralabials; and the scales between supraoculars and semicircles are almost as large as the supraoculars.

Remarks. This species was referred by Smith and Kerster (1955, Herpetologica, 11: 200) to *Anolis milleri,* a species to which no relationship exists as indicated by the uniquely small scales of the supraorbital semicircles and the relatively large ventrals. The dorsals and ventrals are larger than in the only other Mexican species known (Alvarez del Toro and Smith, Herpetologica, in press), which has 22-23 dorsals and ventrals to a head length; the difference is quite striking upon direct comparison. The latter species also has conspicuously smaller humerals than *A. matudai;* they are only slightly larger than dorsals and much smaller than the antebrachials, whereas in *A. matudai* they are subequal to the antebrachials and much larger than dorsals on body.

According to Stuart (1955, Misc. Publ. Mus. Zool. Univ. Mich., 91) no species in Guatemala is particularly like *A. matudai,* although all members of the *heteropholidotus* group are related. *A. heteropholidotus* itself has irregular dorsal scales and enlarged postanals.

The species is named for Mr. Eizi Matuda, at present of Mexico City, formerly our generous host at his finca La Esperanza near Escuintla in Chiapas.

MUSEUM OF NATURAL HISTORY AND DEPARTMENT OF ZOOLOGY, UNIVERSITY OF ILLINOIS, URBANA.

Notulae Herpetologicae Chiapasiae I

By Miguel Alvarez del Toro and Hobart M. Smith

For the past several years the senior author has taken every opportunity to acquire and preserve reptiles and amphibians from the state of Chiapas, Mexico, in the hope eventually of building a sufficiently representative collection to justify a quasi-definitive analysis of the herpetofauna of that state.

Some of the more interesting specimens accumulated to date are reported herewith. The twenty-eight species dealt with are represented by 98 specimens. Two species (of *Anolis*) and two subspecies (of *Anolis limifrons* and *A. tropidonotus*) are described as new; one subspecies is resurrected (*Tropidodipsas fasciata subannulata*); and all the other species here reported provide new distributional or taxonomic information of significance.

Most of the specimens are housed in the Museo Zoológico of Tuxtla Gutierrez and catalog numbers cited with MZTG are in that collection. Specimens in the Museum of Natural History of the University of Illinois are cited as UIMNH. All localities, unless otherwise specified, are in the state of Chiapas, and all specimens save specified exceptions were collected by the senior author.

All localities cited in the following account are to be found on the 1938 American Geographical Society's "millionth" maps of the "Ismo de Tehuantepec" and "Ciudad Guatemala" except for the following: Barra de Paredón (pass on outer chain of islands, SW of Tonalá and Paredón); Cerro del Sumidero (17 km. N Tuxtla Gutierrez); Cerro Ombligo (4 km. SSW of Villa Allende); El Ocote (35 km. NW Ocozocoautla); El Divisadero (6 km. E Tuxla Gutierrez); El Suspiro (9 km. NW Berriozabal); Finca la Valdiviana (16 km. SW Cintalapa); Joigel (18 mi. E San Cristobal las Casas); Parque Madero (in Tuxtla Gutierrez, where the Parque Zoológico [zoo] is located); Rancho Meyapac (3 km. NE Ocozocoautla); Río Sabinal (6 km. E Tuxtla Gutierrez); Villa Allende (=San Fernando, some 18 km. N Tuxtla Gutierrez).

All localities from which the collections here reported were obtained are situated on the Atlantic versant, except for Puerto Arista and Barra de Paredón (both near Tonalá), and Tonalá.

Anolis biporcatus (Wiegmann). MZTG No. 223, El Ocote, April 17, 1955. In life this species is capable of assuming a bright green coloration. The brown phase is assumed upon death. The markings and scutellation of this example, an adult female, appear typical. The species is known from several other localities in Chiapas (Smith and Kerster, 1955, Herpetologica, 11: 193).

Anolis compressicauda Smith and Kerster. Four specimens, all paratypes, are from El Ocote, 600 m., Apr. 15, 1955, now MZTG Nos. 215, 218, UIMNH Nos. 38031-2. The latter two were cited as MZTG Nos. 216-17, designated as paratypes, by Smith and Kerster (1955, Herpetologica, 11: 193).

Anolis (laeviventris) Wiegmann. MZTG No. 254, 10 km. S Jitotol, 1700 m., June 3, 1955. The specimen is a small, mature male, 34 mm. snout to vent, which in direct comparison with specimens from Veracruz seems typical of the species. In life the dewlap was white. This appears to be the first precise record for Chiapas, although Stuart (1955, Misc. Publ. Univ. Mich. Mus. Zool., 19: 18) has already noted the occurrence of the species through the Grijalva Valley of the state and into western Guatemala.

Anolis limifrons microlepis subsp. nov. *Holotype.* Univ. Ill. Mus. Nat. Hist. No. 37971, an adult female collected by Miguel Alvarez del Toro at El Ocote, Chiapas, 600 m., April 15, 1955. *Paratype.* MZTG No. 214, also an adult female, same data as for holotype.

Diagnosis. A member of the *limifrons* group of *Anolis,* having small, smooth ventrals, the scales between the supraorbital semicircles much smaller than the scales comprising the semicircles, small keeled dorsals, rugose or keeled head scales, and (presumably, although no males are known) enlarged postanals. Differing from all other forms of the group in having the combination of exceedingly small head scales, especially in frontal depression across the middle of which are counted 7 longitudinal rows between semicircles; scales of upper foreleg exceedingly small (smaller than ventrals, larger than middorsals); middorsal scales virtually not at all enlarged as compared with lateral dorsals; 5-7 enlarged supraoculars, the innermost row consisting of 3 large scales each with a diameter equal to at least half width of supraocular area from semicircles to lateral edge.

Description of holotype. Frontal depression well defined, asymmetrical, deepest part about halfway between snout and midorbital level, anterior border steep and terminating about one-fourth distance from deepest part of depression to snout; many scales in internasal area tricarinate; nasals in contact with rostral; 5 postrostrals between nasals; scales in nasal area 2-3 times as large as those in frontal depression; a minimum count of 12 scales between canthals across top of head; scales of supraorbital semicircles relatively large, but becoming abruptly smaller anterior to orbits; semicircles separated from each other by 2-3 rows of tiny scales, from interparietal by 3 rows; enlarged supraoculars in essentially 2 rows, 3 in inner row, 2-4 in outer; inner supraoculars large, the largest diameter of each at least ½ diameter of supraocular area; one or two of inner supraoculars in narrow contact with semicircles, a single row of small scales elsewhere separating supraoculars and semicircles; a large scale bordering anterior superciliary medially, separated from supraoculars by a single row of small scales; 7 rows of scales between supraoculars and edge of orbit posterior to superciliary; interparietal of irregular shape, slightly smaller than ear opening; loreals small, in 7-8 rows; 6-8 labials to below middle of eye; suboculars very broadly in contact with supralabials; sublabials (medial to infralabials) keeled; six scales in contact with mental between infralabials.

Dorsals extremely small, keeled, imbricate, only very slightly enlarged medially, somewhat larger (about 1/3) than median laterals, 33 to ½

head length (5.4 mm.); ventrals quite smooth, somewhat acuminate and protuberant, about 1¼ times as large as largest dorsals, 26 to ½ head length. Scales on upper foreleg somewhat larger than largest dorsals, but distinctly smaller than ventrals; 16 lamellae under penultimate and antepenultimate phalanges of fourth toe. Tail scarcely compressed; a single middorsal row of caudals, scarcely enlarged. Dewlap scarcely evident.

Snout-vent, 40 mm.; snout-tympanum, 10.7 mm.; ear opening 1.0x0.5 mm.; hind leg, 29 mm.; tibia, 9.5 mm.

Color, a light tan above, lighter below; no markings.

Variation. The only other known specimen, the paratype, differs but little from the type. It is also a female and measures 38 mm. snout to vent. The interparietal is large (1.5x1.0 mm.), exceeding the size of ear opening; none of the supraoculars is in contact with the semicircles; and the frontal depression is more nearly symmetrical, its anterior edge about halfway between deepest part of the depression and tip of snout.

Remarks. This taxon closely resembles *Anolis limifrons* and its various northern representatives such as *rodriguezi* and *aureolus.* None of the northern forms possesses such tiny scales on the head, however, especially in the frontal depression. None has such tiny dorsals, and none has such small scales on the limbs. Seemingly the size of dorsals and most limb scales is linked, for the *relative* size of dorsals and the scales on upper foreleg is in effect the same in all three forms mentioned, whereas the ventrals are of about the same *actual* size. Thus the upper foreleg scales are larger than the dorsals in all, but only in *A. l. microlepis* are they distinctly smaller than (rather than equal to or larger than) the ventrals.

Actually *A. l. microlepis* appears to resemble *A. limifrons limifrons* very closely, both having very small head scales and dorsals. However, in *limifrons* the supraoculars are much smaller and more numerous, *fide* both Boulenger (1885, Cat. Liz. Brit. Mus., 2:49) and Bocourt (1873, Miss Sci. Mex., livr. 2: p. 14, fig. 20). The occurrence of such similar types in two widely separated areas (perhaps range extremities) poses a tantalizing problem in phylogeny and in current relationships between the known taxa. We here regard *A. limifrons microlepis* a subspecies simply because it seemingly posseses a range parapatric with those of other members of the group in Mexico, yet it appears to be fundamentally similar to them. Certainly the apparently unique features of *A. l. microlepis* are of a type subject to intraspecific variation.

The holotype contains one large intact egg, 9 x 4.5 mm.; there appear to be other eggs present, but they are either immature or seem to have failed to develop properly. The paratype contains no mature eggs.

Anolis parvicirculata sp. nov. Holotype, Univ. Ill. Mus. Nat. Hist. No. 38045, El Suspiro, Chiapas, 1200 m., July 8, 1955, Miguel Alvarez del Toro. *Paratype,* Amer. Mus. Nat. Hist. No. 66957, between Ocozocoautla and Quechula, Chiapas, Jan. 22, 1946, Thomas MacDougall.

Diagnosis. Presumably a member of the *heteropholidotus* group of *Anolis,* having smooth ventrals and small scales in the supraorbital semi-

circles, smaller than scales in the two rows between semicircles. Distinguished from all other described species in Mexico by the combination of characters described, and from more southern species by absence of enlarged postanals and regularity of size of body scales.

Description of holotype. Adult male; head scales rather strongly unicarinate except in frontal depression, where accessory ridges are present in some; internasals rather small, elongate, 6 between nasals; 7 postrostrals; nasal separated from rostal; 4-5 canthals; 2-3 small scales extending forward between anterior canthal and supralabials; scales of supraorbital semicircles considerably smaller than those between, which form 2 rows in frontal region; scales in frontal depression rather large; 6 scales between posterior canthals; 10 to 12 enlarged supraoculars, scales of inner row largest and as large as nearest scales of supraorbital semicircles; latter separated from enlarged supraoculars by one row of small scales; 2-3 rows of tiny scales between supraoculars and superciliaries; 6 rows of loreals, upper somewhat smaller; suboculars separated from supralabials except at extreme rear; interparietal scarcely larger than adjacent scales, much smaller than ear opening; no enlarged sublabials; 9 supralabials to below middle of eye.

Dorsal scales keeled, small, but several times as large as laterals, gradually merging with laterals, gradually increasing in size toward median line, about 25 rows across back, a short distance in front of groin level, distinctly larger than laterals, largest ones about size of ventrals; latter not quite smooth, not mucronate although a little convex; dorsals 23, ventrals 22, in one-half head length (6.75 mm.).

Tail oval in cross-section; middorsal scales only slightly larger than laterals; subcaudals keeled except at very base of tail; no enlarged postanals.

A weak axillary pocket; humerals somewhat larger than largest dorsals on trunk; largest scales on forearm about twice as large as humerals; largest scales of shank and thigh subequal in size, intermediate between humerals and antebrachials; pads rather poorly developed; 15 lamellae under 2nd and 3rd phalanges (counting distally) of 4th toe.

Color a nondescript gray-brown; dewlap in life orange (quickly alcohol-soluble) with a reddish central spot (moderately resistant to alcohol).

Snout to vent, 46 mm.; tail, 82 mm.; head length to rear of tympanum, 13.7 mm.; tympanum 1.9 mm. x 1.0 mm.; head width, 7.5 mm.; tibia 13 mm.; hind leg 43 mm.

Variation. The paratype is a larger male, snout to vent 50 mm., head length 15 mm.; tibia 15 mm. The scutellation seems to be virtually identical with that of the holotype.

Remarks. No other described Mexican species has larger scales between the supraorbital semicircles than those within the semicircles themselves, at least between orbits. There are no Mexican relatives, but several Central American species appear to belong to the same group.

Anolis heteropholidotus Mertens appears to be related, and according to Stuart (*op. cit.*: 14) *A. cobanensis* Stuart may belong to the same group.

Anolis pygmaeus sp. nov. Holotype. An adult male, UIMNH No. 37975, from El Ocote, 600 m., collected April 15, 1955, by Miguel Alvarez del Toro.

Diagnosis. A small species of the genus Anolis, an adult male measuring 35 mm. snout to vent; dorsal scales distinctly but not strongly keeled, rather broad, with turned-up edges that give the scales a tricarinate appearance; dorsals distinctly larger than ventrals, about 12 to ½ head length (5 mm.); ventrals distinctly but not strongly keeled, about 22 to ½ head length; ear opening large, a little larger than interparietal; head scales flat, feebly keeled; supraorbital semicircles separated from each other by two rows of small scales, from interparietal by three rows; six loreal rows; dewlap pale red in life, unspotted; postanals not enlarged.

Description of holotype. Enlarged supraoculars in a group of some five or six scales, the innermost three or four largest and at least in part in contact with supraorbital semicircles, weakly keeled and rugose; and prefrontal concavity strongly marked, extending posteriorly between orbits; scales in prefrontal area larger than those in internasal, frontal or parietal areas, minimum intercanthal count eight; nasal area somewhat elevated over canthal zone; four canthals; suboculars in moderately broad contact with supralabials; eight supralabials to below middle of eye.

Dorsal scales in about 11 longitudinal rows, abruptly enlarged, much larger than small, nearly granular laterals; no axillary pocket whatever; tail more or less rounded, not markedly compressed, with a single mid-dorsal row of scales; 13 lamellae under distal two phalanges with pad on 4th toe.

Tibia 8 mm.; ear opening 1.3 mm. x 0.8 mm.; interparietal 1.0 mm. x 0.5 mm., tail 40 mm., extreme tip (2-3 mm.) missing.

A dull ashen brown above, whitish below, without distinct markings save a few conspicuous black flecks on throat lateral and anterior to dewlap.

Other data are as given in the diagnosis.

Remarks. The relationships of *Anolis pygmaeus* are not clear. No other species known from Guatemala or Mexico has the combination of dorsals larger than ventrals, no axillary pocket, supraoculars in several rows, and ventrals distinctly keeled. Possibly *A. crassulus* is related, but relationship with the *tropidonotus* groups apparently is excluded by the absence of an axillary pocket.

Anolis sallaei wellbornae Ahl. Seventeen specimens are as follows: Parque Madero, Aug. 14, 1953, Mar. 5, April 14, 1954, and June 22, 1955 (MZTG Nos. 5, 106-7, 265, UIMNH Nos. 37965-8); Villa Allende, Oct. 20 and Dec. 28, 1953 (MZTG Nos. 41, 46, UIMNH No. 37969); Barra de Paredón, Feb. 23, 1954 (MZTG Nos. 68-69, UIMNH No. 37970); Río Sabinal, Mar. 4, 1955 (MZTG No. 192); El Suspiro, 1200 m., June 21, 1955 (MZTG No. 263); and Lomas del Divisadero, 530 m., July 4, 1955 (UIMNH No. 38046).

We have been unable reliably to distinguish more than one form in this assemblage, secured from both Pacific (Tonalá) and Atlantic versants (interior valley) of the state. Most have large dorsals, in the sense of Stuart (*op. cit.*: 23), but a few have small ones. We were unable to make reliable counts from axilla to groin as did Stuart, and instead counted the number of median dorsal scales in the middle and rear trunk area corresponding to the head length.

Number	Sex	Snout-Vent	Dorsals to head length	Scales between supraorbital semicircles	Scales between interparietal and supraorbital semicircles
5	♂	46.8	32	Sep. 1 row	2-2
37965	♂	47.0	32	Cont. 2 scales	1-2
107	♂	49.0	32	" 1 "	1-1
106	♀	35.3	37	" 1 "	1-2
46	♀	36.0	35	" 1 "	1-1
37968	♀	37.0	43	" 1 "	1-2
37967	♀	37.5	37	" 2 "	1-1
37969	♀	37.7	35	" 2 "	2-2
37966	♀	38.0	40	" 1-2 "	1-1
41	♀	39.5	36	" 2 "	1-1
265	♀	40.8	32	" 2 "	1-1
38046	♀	45.0	36	" 2-3 "	1-1
192	♀	45.4	34	" 1-2 "	1-2
263	♀	49.0	41	Sep. 1 row	2-2
37970	♀	46.2	31	" 1 "	2-2
69	♂	45.0	32	Cont. 2 scales	1-2
68	♂	45.6	35	" 1 "	1-2

Table 1. Scale counts and measurements in *Anolis sallaei*.

The range of variation was from 31 to 43, the higher figures occurring in the smaller females, and certainly falling within Stuart's small-scaled group. The only counts higher than 36 occur in the Tuxtla-El Suspiro series, which might thus be regarded as intergrades between the more northwesterly large-scaled group and the more easterly small-scaled group. Presumably the influence of the small-scaled group does not affect the Tonalá population, although a series of 3 is inadequate properly to explore this possibility.

There is some variation in extent of keeling of the scales in the prefrontal depression. In some specimens all the scales in this area are rather strongly keeled or rugose whereas in others some scales are quite smooth, and the remainder feebly keeled or feebly rugose. We could detect no consistent geographic correlation of this variation in this series.

The present series is referred to the subspecies *A. s. wellbornae* rather than to *A. s. sallaei* primarily on the basis of closer approximation of the supraorbital semicircles to each other and to the interparietal, although percentages given by Stuart (*op. cit.*: 24) would not warrant such a separation. Whether the more northern Atlantic and Pacific (with the more southern Atlantic areas as about Tuxtla) populations are in reality separable is still open to question.

Anolis tropidonotus spilorhipis subsp. nov. Holotype, UIMNH No. 37972, an adult male from Cerro Ombligo, 1280 m., taken March 20, 1954, by Miguel Alvarez del Toro. *Paratypes,* MZTG Nos. 112-115, UIMNH Nos. 37973-4, topotypes; and UIMNH No. 37251, Arroyo Mono Blanco, near Juchitán, Oaxaca, taken Mar. 5, 1951, by Thomas MacDougall.

Diagnosis. Similar to *A. tropidonotus,* having a deep axillary pocket; large, heavily keeled dorsals somewhat larger than ventrals; head scales more or less uniform in size and appearance, generally elongate and strongly keeled, some tricarinate; largest diameter of ear opening not more than 2/5 distance from eye opening; and snout-vent length reaching 58 mm. in adults. Distinguishable from *A. t. tropidonotus* by having usually fewer scales between canthal ridges (5-8 in 8 examples, av. 6.6 in minimum count, 88% with 7 or fewer, as opposed to 7-10, av. 8.4 in 56 examples, 5.4% with 7 or fewer in *A. t. tropidonotus*), dewlap with one or two sharply defined black spots toward anterior edge (as opposed to a dim, dark curved streak near edge of dewlap, or no dark marking at all, in *A. t. tropidonotus*), and dorsal scales distinctly although but slightly larger than ventrals (subequal or smaller in *A. t. tropidonotus*).

Description of holotype. Head scales strongly keeled, the larger ones tricarinate; scales on snout in front of eyes larger than those in parietal area, counting a minimum of 5 between (not including) canthal scales; two large supraoculars in broad contact with supraorbital semicircles; 7-8 supraoculars, 3 inner scales larger than 4 or 5 outer scales; latter separated from superciliaries by 2-3 rows of small scales; interparietal scarcely enlarged, separated by 2-3 rows of scales from supraorbital semicircles; latter separated midfrontally by a minimum of one scale; only 4 rows of scales between nasals, and 4 in contact with nostril between nasals; latter in contact with rostral.

A minimum of 4-5 loreal rows; one row of scales between suboculars and labials; 6 labials to below middle of eye; ear opening small, 1 mm. x 1.6 mm., eye opening (lids closed) 2.5 mm.

Dewlap extending posteriorly one third of distance between axilla and groin; dorsal scales large, gradually increasing in size posteriorly from postoccipital region to middle of axilla-groin distance; scales at rear of dorsum distinctly but not greatly larger than largest ventrals, 6½ in one-half head length (7 mm.); 8 ventrals in ½ head length; postanals not enlarged; 13 lamellae under two distal phalanges of pad on 4th toe.

Dorsal surface pale brown; a series of small, dark brown spots down median dorsal line, each spot about the size of or a little larger than a scale, 8 between occiput and sacrum; dewlap a bright blood red, paler and more yellowish peripherally; a conspicuous, bold, elongate black spot just inside anterior edge of dewlap, and another smaller spot directly dorsal to the latter at junction of dewlap and body.

Snout to anterior border of ear, 14 mm.; tibia, 15 mm.; hind leg, 47 mm.; snout-vent, 55 mm.; tail 85 mm.

Variation. The paratypes include 5 males, 2 females, all adults. The dewlap is marked the same in all males, and is scarcely evident in the two females. The scales on the snout are relatively large as in the holotype; the minimum counts between the canthal ridges are 6 (2), 7 (4) and 8 (1).

Comparisons. Clearly the present population is closely related to *A. tropidonotus,* from which it appears to differ primarily in color and marking of dewlap, and in the larger size of scales on the snout and dorsum. Among the 56 *A. t. tropidonotus* available, no male has the discrete dark marking on the dewlap characteristic of *A. t. spilorhipis;* they often exhibit, however, two semicircular dark streaks paralleling the edge of the dewlap. Presumably the markings of one race could readily have evolved from those of the other.

The size of scales on the snout is subject to some variation; some paratypes have the scales in the internasal region but little if any smaller than they are in *A. t. tropidonotus.* The scales in the midfrontal region seem consistently larger, however; in 56 *A. t. tropidonotus* a minimum intercanthal count of seven occurs only 3 times, eight 29 times, nine 21 times, and ten 2 times.

Range. The range of *A. tropidonotus* is restricted to Atlantic slopes from Mexico as far south as Nicaragua, according to Stuart (*op. cit.*: 28) and others. It is essentially a lowland species, although Stuart (*loc. cit.*) cites a record for elevations as high as 1700 m. in Honduras.

The present population, the first recorded for the state of Chiapas, is, like others previously recorded, seemingly limited to the Atlantic versant, but unlike other Mexican populations it occurs at a considerable elevation (1280 m. on Cerro Ombligo), certainly a similar elevation at Arroyo Mono Blanco (about 20 miles almost due north of Tapanatepec, Oaxaca). Both known localities of occurrence of *A. t. spilorhipis* are in the southern, upper reaches of the drainage system of the Río Grijalva, where either isolation or a difference in altitude presumably has been responsible for differentiation of a distinct race of *A. tropidonotus.* Contiguity of range presumably occurs at lower elevations.

Whether *A. t. spilorhipis* may occur more widely in Chiapas and Guatemala is unknown. It seems quite likely in view of somewhat similar ranges evident among typically lowland species (such as *Sceloporus melanorhinus, Ameiva undulata*), whose populations in the central valley of Chiapas have become differentiated and extend into Guatemala.

Of considerable interest is the remark by Stuart (*loc. cit.*) that Honduran and Nicaraguan populations possess a spotted dewlap, presumably much as in *A. t. spilorhipis.* The significance of this apparent parallelism is an intriguing problem.

Laemanctus serratus Cope. MZTG No. 248, Villa Allende, May 30, 1955 (a female with three well-developed eggs); UIMNH No. 37987, Meyapac, July 22, 1954. The specimens appear to be typical of the species.

No specimens have previously been reported from the state of Chiapas,

the nearest being from Yucatán, southern Veracruz and Oaxaca (Tlacolula).

Sceloporus carinatus Smith. Fourteen specimens: MZTG Nos. 3, 14, UIMNH Nos. 37983-5, Parque Madero, 525 m., Aug. 12 and 25, 1953, Mar. 25 and April 1, 1954; MZTG Nos. 55-58, UIMNH Nos. 37981-2, El Divisadero, 550 m., Feb. 10, Jan. 15, Mar. 2, Mar. 31, 1954; MZTG No. 43, Villa Allende, Oct. 20, 1953; and UIMNH No. 38047, Rancho Meyapac, 1050 m., July 16, 1955.

The femoral pores vary from 8-9 to 13-13, the larger series occurring in adult males (8, one; 9, three; 10, six; 11, five; 12, three; 13, four); the dorsals vary from 36 to 44 (36, one; 38, three; 39, two; 40, four; 41, two; 44, one).

The color in life of an adult male (No. 38047) is much brighter than revealed by preserved specimens: dorsal color dark brown with yellowish dots; dorsolateral light lines yellowish; middorsal zone with 12 obscure, dark, V-shaped marks; tail dark straw-color; ventral surfaces white, with a gray mottling; all of throat and lower lips egg yellow; an oblique yellow line from canthus rostralis to subocular region.

Sceloporus melanorhinus stuarti Smith. MZTG No. 37, UIMNH No. 37986, Parque Madero, Dec. 11 and Aug. 29, respectively. The femoral pores are 19-20 ♂, 17-17 ♀ respectively; there is no bare or granular skin in the lateral nuchal pocket; and there are certain peculiarities in pattern: the female lacks dark gular lines, and the male has only faint vestiges of a dark median border on the lateral belly patches, the whole gular region is dark save a light midventral spot anteriorly and a dark brown sublabial area heavily stippled with black.

The validity of *S. m. stuarti* has been questioned, at least if the chief basis of distinction is the depth and scutellation of the lateral nuchal pocket, because these features are dependent upon degree of mite infestation. Whether true or not, the present specimens do possess shallow, scaly pockets as previously noted as characteristic for the subspecies. As indicated in the original description, certain features of pattern may well be characteristic of the Chiapas-Guatemala race; the faint median border of the lateral belly patches in males seems particularly valid. The gular pattern of the female does not seem unique, since the present specimen has no pattern whereas the other female described had a very bright pattern.

Sceloporus variabilis variabilis Wiegmann. Six specimens; MZTG Nos. 7, 88, UIMNH No. 37977, Tuxtla Gutierrez, Aug. 20, 1953, Jan. 10, 1954, and Feb. 2, 1954, respectively; MZTG Nos. 23, 44, UIMNH No. 37976, Villa Allende, 800 m., Oct. 12, 1953, Nov. 5, 1953, and Mar. 20, 1954 respectively. The dorsals vary from 51 to 57, the femoral pores from 10 to 13 (both extremes in females); the subnasals are absent (fused with cantha!) on both sides of two, one side of one. These data require allocation of the specimens with *S. v. variabilis*, with which they agree in other respects as well.

Scincella assata taylori (Oliver). MZTG No. 134, from Joigel, 2100 m., July 14, 1954. A mature female, the specimen laid four eggs a few

days after capture. The only previous record in Chiapas for this species is for Tonalá. Its presence so far from Pacific slopes is quite unexpected, although the species has been recorded from Atlantic slopes in Oaxaca (Matias Romero). The dorsals number 63; forelegs 9 mm.; hind legs 14 mm.; axilla-groin 30 mm.; scale rows 26; tail olive, with a dark lateral streak near base, lacking crossbars.

Scincella cherriei cherriei (Cope). MZTG No. 210, El Ocote, April 14, 1955. The specimen is an adult female and laid 4 eggs during its captivity. Although this species has previously been recorded from Chiapas (Palenque), the present record extends the range a considerable distance southwestward. The dorsals number 64; foreleg 14 mm.; hind leg 18.5 mm.; axilla-groin 32 mm.; scale rows 32; tail dimly cross-barred.

Eumeces sumichrasti (Cope). MZTG No. 211, from El Ocote, April 15, 1955. This specimen, an adult 75 mm. snout to vent, lacks all evidence of light stripes save for faint evidence of the dorsolateral lines; the lateral dark lines are clearly defined, occupying scale rows 4 to 6. Scale rows 26; scutellation of head typical except dorsally, where obvious anomalies occur, due seemingly to repair of an old injury (a fresh cut on head partly obscures the aberrant scutellation).

Gymnophthalmus sumichrasti (Cope). Eleven specimens: MZTG Nos. 32, 96, 101, 103, 141, 247, and UIMNH Nos. 37988-90, 38043-4, all from Parque Madero, Dec. 7, 1953, Apr. 5, 8, 14, 1954, Sept. 13, 1954, and May 25, 28, July 1, 25, 1955. These specimens agree well with previous accounts (Stuart, 1939, Occ. Papers Univ. Mich. Mus. Zool., 409: 5-6), save that on one side in four (Nos. 103, 37990, 38043-4) the prefrontal is separated from the loreal by contact of the supraocular and internasal. Since in one specimen (UIMNH No. 37239, San Pablo, nr. Tehuantepec, Oaxaca) of three others available from Oaxaca the same aberrant condition obtains on both sides, Stuart's suggestion (*loc. cit.*) that *G. birdi* is subspecifically related to *G. sumichrasti* seems well founded, inasmuch as this is seemingly the sole distinguishing feature of the two forms. We refrain from proposing such a taxonomic change here since both forms in turn may well be subspecifically related to still another nominal species, *G. speciosus* (Hallowell 1860) of still earlier date; in turn all three may well be subspecies of *G. lineatus* (Linnaeus). Until definitive evidence is available bearing upon these relationships only confuson could result from abandonment of the current status of these four nominal species in favor of a premature guess on their correct taxonomy.

The species has not previously been reported authoritatively from Chiapas, although a tentative sight record is available from San Ricardo (Smith and Taylor, 1950, Bull. U. S. Nat. Mus., 199: 192).

Loxocemus sumichrasti Bocourt. MZTG No. 2, Finca La Valdiviana, Aug. 25, 1953. This species has been reported previously from Pacific slopes from Colima to the Isthmus of Tehuantepec. The specimen is a typical adult female with the entire ventral strongly pigmented, and nearly as dark as the dorsal surface. The ventral surface of the head is especially dark in color, closely approaching that of the dorsal surface.

Conophis vittatus vittatus Peters x *C. v. viduus* Cope. MZTG Nos. 178, 188, 255, and UIMNH Nos. 37992, 38036-7, all from Parque Madero, collected Dec. 11, 1954, Feb. 11, 1955, June 8, 1955, and Aug. 18, 28, 1955. Nos. 188 and 37992 were in copulation when found on Feb. 11.

This species has not previously been reported east of Oaxaca. That these specimens should not be typical of the Isthmus subspecies, *C. v. viduus* Cope, is somewhat surprising. Actually they are intermediate and could readily be allocated with either subspecies. The median light stripe is well-defined in all; in one it is very fine and discontinuous (interrupted at each scale); in two it is about half a scale wide; in one it is slightly less than a full scale in width; in one it is one scale wide; and in one it is one and two half scale rows wide at its widest point.

In none is the median stripe as broad throughout its length as in typical *C. v. vittatus,* yet the variation exhibited in the present series is not typical of *C. v. viduus.* The lateral stripe also is of different widths in the Chiapas specimens; in one it is restricted to two half-rows, as is typical *C. v. vittatus,* in two it is two full and two incomplete rows wide as in *C. v. viduus,* and in the other three it is intermediate in width between these extremes. Despite the provenience of the Chiapas series from an area far distant from the zone of contact of the known ranges of *C. v. viduus and C. v. vittatus,* the specimens can scarcely be regarded as anything but intergrades. This suggests that either these are relict representatives of a more primitive stage of evolution, or that more typical *C. v. vittatus* occurs still farther to the east. The former hypothesis now appears the more probable of the two.

Elaphe triaspis intermedia (Boettger). MZTG Nos. 100, 174, from Cerro del Sumidero, 1200 meters, taken July 16, 1953, and April 8, 1954. These are nearly mature adults, both lacking pattern.

Enulius unicolor (Fischer). MZTG No. 154, Parque Madero, Oct. 11, 1954. A single adult female has 196 ventrals, the tail broken; 7 supralabials, two (3 and 4) entering eye; no preocular; 2 postoculars; a suggestion of a light collar on one side just behind head. The rostral is a little better developed than in more northern *E. unicolor,* actually appearing intermediate between that form and *E. sumichrasti* Bocourt. The status of the latter form is open to question, but requires further specimens for a satisfactory solution.

Leptophis diplotropis diplotropis (Günther). MZTG No. 144, from Parque Madero, July 16, 1953. A typical adult, somewhat emaciated, provides a basis for this the only record of the species from areas east of Oaxaca. There are 177 ventrals and 115 caudals, thus agreeing in general with the averages for Tehuantepec specimens (Oliver, 1948, Bull. Amer. Mus. Hist. 92: 209).

Scaphiodontophis albonuchalis Taylor and Smith. MZTG No. 99, Villa Allende, Dec. 10, 1954; and UIMNH No. 38039, Parque Madero, Aug. 2, 1955. Adult males, respectively 474 mm. and 350+ mm. total length, 212 mm. and 64+ mm. tail length; 138, 135 ventrals; 125, 28+ caudals. Seven white rings are restricted to the anterior 3/8 of the

body, the remainder of which is uniform brownish olive above except for a small black dot on each middorsal scale in one, a row of black dots on vertebral and fifth scale rows in the other.

The nominal species *S. nothus* Taylor and Smith, *S. cyclurus* Taylor and Smith, *S. zeteki* Dunn, and *S. albonuchalis* are morphotypes that almost certainly do not accurately correspond with the true (populational) species. The absence of clear-cut differences aside from seemingly meristic pattern variations, the known sympatric occurrence of *S. nothus* with *S. cyclurus* and of *S. nothus* with *S. albonuchalis,* and the astonishing similarity of the two most geographically remote forms (*S. zeteki, S. cyclurus,* Panamá and Tamaulipas respectively), suggest so many populational possibilities that to juggle names at the present time in an attempt to represent any one of the several possible arrangements would be undesirably premature and, ultimately, confusing. For the present we accordingly retain the current names for the morphotypes as the least disturbing, although certainly temporary, course of action. Martin (Copeia, 1955: 178) has adopted a similar policy.

The nominal species *T. albonuchalis* has previously been recorded from a single locality in Chiapas (Escuintla).

Scaphiodontophis nothus Taylor and Smith. MZTG No. 126, UIMNH Nos. 37994, 38040, Parque Madero, June 5 and 15, 1954, and Sept. 5, 1955 respectively; 151 ♀, 141 ♂, 135 ♂ ventrals; 111, 130, 124 caudals; white rings on body 11, 13, 12 and tail 2, 2, 0 (at very base, the posterior one dim in one, well-defined and conspicuous although narrow in the other); total length 520 mm., 557 mm., 583 mm.; tail length 215 mm., 260 mm., 275 mm.

The present specimens are the only ones of this nominal species on record, except the type from Potrero Viejo, Veracruz. They differ somewhat from the type, primarily in having rings at the base of the tail.

Tantilla rubra Cope. MZTG No. 76 and UIMNH Nos. 37991, 38041, Parque Madero, Jan. 6 and Oct. 14, 1954, and Aug. 24, 1955, respectively; MZTG No. 259, Berriozabal, June 21, 1955. The species has not previously been reported from the state of Chiapas. The ventrals and caudals (154, 152, 155, 160; 66, 64, 50+, 67, respectively, all males) do not evidently differ from those of Isthmus specimens (Smith, 1943, Proc. U. S. Nat. Mus., 93: 476), nor by direct comparison were differences in marking discerned.

Tropidodipsas fasciata subannulata (Muller). UIMNH No. 38042, an adult female, El Divisadero, Mar. 20, 1955. Total length 553 mm., tail 117 mm., scale rows 17; ventrals 187, caudals 73; anal entire; labials 7-8; eye diameter 2.8 mm., distance from eye to lip 1.4 mm.; scales very feebly keeled, smooth in outer 1 or 2 rows; posterior chinshields about half length of anterior; body slightly compressed; frontal 3.3 mm. wide, 3.8 mm. long. Light rings stippled, gray in appearance, one scale in length at midline, two at first scale row, still wider (2 to 4 ventrals) on belly. Dark rings black, no brown evident. Light rings 16 on body, 8 on tail; 9 of these on body broken at middorsal line, only one completely broken ventrally although several others are narrowly complete mid-

ventrally; light rings somewhat larger and spaced farther apart anteriorly (13 scale lengths) than posteriorly (9-10 scale lengths).

The exact identity and range of *Tropidodipsas fasciata* Günther remains in doubt. The specimen figured by Günther (1894, Biol. Centr. Amer., pl. 50, fig. B) is said by him (*op. cit.*: 139) to be "the type," further identified as "spec. *a*" of the British Museum, which Boulenger (1894, Cat. Snakes Brit. Mus., ed. 2, 2:295) reveals is one of the former cotypes from "Mexico." The type locality has been restricted by Smith and Taylor (1950, Univ. Kans. Sci. Bull., 33: 352) to Chichen Itzá, Yucatán, whence a specimen is available in the Chicago Natural History Museum (No. 36194). The latter specimen and another from a nearby locality, Yohdzonot (CNHM No. 36195), were examined both by Dr. L. C. Stuart and the junior author, and independently identified as *T. fasciata.* Certain features are described by Stuart (1942, Proc. Biol. Soc. Washington, 55: 179), and we can add that the specimen from Chichen Itzá possesses 180 ventrals. Nevertheless there is no absolute certainty that the features of the type are those of the Yucatán population; until this is determined the restriction of the type locality to Chichen Itzá must be considered provisional, for other records reveal that the species may occur also in Veracruz, whence the type actually may have come. On the other hand the Veracruz records may very well be based upon misidentified specimens of *T. sartorii,* for all the records are 70 years old or more; no recent records for the species in the Veracruz area exists. If a Veracruz population does exist, and does not differ taxonomically from the Yucatán population, the restriction of type locality to Yucatán may stand. At present it is necessary to assume that both populations, if two actually exist, are taxonomically the same.

In any event, the type of *T. fasciata* rather clearly represents a population different from that represented by the present specimen, referred to *T. f. subannulata.* The only distinctions that seem secure are in pattern, however; *T. f. fasciata* has as many as 38 light rings on body and tail (the type has 32), whereas the present specimen and the type of *T. f. subannulata* have but 14-16 rings on the body, 7-8 on the tail. Differences in ventral counts do not appear significant.

Accordingly it appears reasonable to regard Muller's *subannulata* as a subspecies of *T. fasciata,* presumably occurring on Pacific slopes of Mexico southeastward from the Isthmus of Tehuantepec. Only two specimens are known—the type from "Mexico," and the present specimen which provides the only definite indication of range.

The records of *T. fasciata* from the Isthmus of Tehuantepec previously referred to *T. guerreroensis* are of special interest in their relation to *T. f. subannulata.* The records involved are for Mixtequilla (Smith, 1943, Jour. Washington Acad. Sci., 33: 372-373), Santa Efigenia and Cacoprieto (Sumichrast, 1880, Bull. Soc. Zool. France, 5: 184). The Mixtequilla specimen was described by Smith (*loc. cit.*), and it seems very likely that Mocquard's description and figures (1908, Miss. Sci. Mex., 16: 872-3, pl. 70, fig. 3) of Sumichrast's two specimens from the "Isthmus of Tehuantepec" pertain to the Santa Efigenia and/or Cacoprieto specimens. There is an astonishing similiarity in all these four specimens (one reported by Mocquard is from "Mexico," a Werner specimen). All

have 31 to 32 light rings on the body, and contrary to the statement by Smith (1943, *loc. cit.*) their patterns do not match the curious broken, speckled pattern of the type of *T. querreroensis.* They are not now distinguishable from *T. f. fasciata,* whose range may be presumed to extend from Yucatán to the Pacific slopes of the Isthmus of Tehuantepec, in mesic areas.

The differences between *T. guerreroensis* and *T. fasciata* pertain primarily to pattern; in fact, the other apparent differences are probably not significant. The pattern is typically broken in *guerreroensis,* so that the light rings are not countable. It is noteworthy that in the specimen from Mixtequilla the rings are at least discernible, even though not readily countable, whereas in the Guerrero examples the rings are not even discernible. An approach to the features of *T. fasciata* is thus suggested. Since primarily pattern is involved in distinguishing *guerreroensis* from *fasciata,* and since there is some trend of one toward the other, it seems reasonable to regard these two also as subspecific.

The subspecies and ranges of *T. fasciata* thus now appear as follows:

T. f. fasciata Günther from Yucatán across the Isthmus of Tehuantepec, and possibly northward into Veracruz (definite records: Yohdzonot, Chichen Itzá, *Yucatán*; Cacoprieto, Santa Efigenia and Mixtequilla, *Oaxaca*; possible records San Andrés Tuxtla, Cordoba, and Jicaltepec, *Veracruz*).

T. f. subannulata (Müller) on Pacific slopes from western Chiapas and possibly adjacent Oaxaca southeastward probably into Guatemala (only known locality Tuxtla Gutierrez, Chiapas).

T. f. guerreroensis Taylor, on Pacific slopes, probably from central Oaxaca to Jalisco (only known locality Buena Vista, *Guerrero*; probable locality, Uruapan, *Michoacán.*

Micrurus elegans elegans (Jan). *M. e. verapacis* Schmidt. UIMNH No. 38038, an adult female from El Suspiro, July 8, 1955, at an elevation of 1200 m. The specimen was found on a misty day crawling into a crack in a cliff. Its complex color pattern is typical of the species. Ventrals 218, caudals 32, 2-3 labials entering eye, 18 triads on body. Although expected, no previous records for this species in Chiapas are known. Curiously, this specimen falls exactly between *M. e. elegans* and *M. e. veraepacis* in the table of variation given by Schmidt (1933, Zool. Ser. Field Mus. Nat. Hist., 20: 32). Also the specimen is from a somewhat intermediate zone between the known ranges of the two forms (although a "Tabasco" specimen is referred to *M. e. elegans*), and thus the present example can scarcely be considered anything but an intergrade. A clear outline of the total area of intergradation of these two forms is nevertheless not yet apparent.

Micrurus nigrocinctus browni Schmidt and Smith. Five specimens are as follows: MZTG No. 125, Meyapac, 1050 m., June 12, 1954; MZTG No. 183, Bombaná, nr. Copainalá, Dec. 26, 1954; MZTG No. 200, UIMNH No. 37995, Parque Madero, April 4, and June 4, 1955; MZTG No. 250, El Sumidero 400 m. Respectively, the ventrals are 214♂, 211♂, 228♀, 210♂, 229♀; caudals 46, 51, 35, 50, ?; black rings on body and tail 22-6, 20-7, 23-4, 17-6, 20-?; width of black rings on belly 3-4, 3-4, 3, 4-6, 3 ventrals. Black tips on red scales are of scattered

occurrence in the first two, absent in the others. The yellow rings are one scale wide, and no specimen has the prefrontal in contact with or approaching the labials.

The present race has previously been reported from Chiapas, but confirmation on the basis of an adequate series has been wanting. These specimens remove all doubt that typical *M. n. browni* occurs as far south as Chiapas but otherwise shed no light on the question of intergradation with *M. n. zunilensis* Schmidt and the status of *M. n. wagneri* Mertens and *M. n. ovandoensis* Schmidt and Smith (Mittleman and Smith, 1949, Trans. Kans. Acad. Sci., 52: 86-88).

Pelamis platurus (Linnaeus). MZTG No. 166, Puerto Arista, nr. Tonalá, taken Oct. 16, 1954. Presumably this species occurs along the entire Pacific coast of Mexico from the Gulf of California to Guatemala, but no records have previously appeared from the state of Chiapas. The specimen is a typical tri-colored adult with a light lateral streak separating the black dorsal coloration from the gray ventral pigmentation.

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A New Fringe-Limbed *Hyla* (Amphibia: Anura) from a New Faunal District of Mexico

By I. Lester Firschein and Hobart M. Smith

Among specimens secured by the senior author during the summer of 1953 in the vicinity of Volcán San Martín in southern Veracruz is a single juvenile example of the bizarre fringe-limbed frogs comprising the *tuberculosa* group of the genus *Hyla*. Six other species clearly belong to this group; four are known from Central America (Nicaragua and Costa Rica) and two from South America (Columbia and Ecuador).

The single specimen now at hand was taken in a cloud forest completely isolated by lowlands from other areas of similar habitat. Although this specimen does not reveal adult features, because of the isolation of San Martín we regard it improbable that the identity of the population of fringe-limbed hylas of that area could ever be in doubt. Although more than one species of this group possibly could inhabit this area, the probability is not great since Mexico is on the extreme periphery of the group range. Furthermore, the specimen does exhibit characters that appear reliable for differentiation from other known species, and presumably they would suffice were sympatric species of the same group later discovered.

In reference to the most conspicuous feature of this group, which brings to mind the interior decorator's valance, we name the present species

Hyla valancifer sp. nov.

Holotype. Univ. Ill. Mus. Nat. Hist. No. 35398, a juvenile collected by I. Lester Firschein on Volcán San Martín, 4500 ft., Veracruz, Mexico, Aug. 13-14, 1953.

Diagnosis. A member of the *tuberculosa* group of arboreal frogs of the genus *Hyla,* having a pronounced scalloped fringe on lateral edges of pes and lower forearm; a pronounced, spineless prepollex. Distinguished from other members at least by the webbing (not full on outer fingers), nearly vertical lores, and pattern (strongly barred limbs and sides of head).

Description of type. Snout and head rather thick; eye a little shorter than distance from nostril, about equal to interorbital distance; tympanum not clearly evident (juvenile characteristic?); tongue round, entire, vomerine eminences poorly developed, toothless, equidistant from each other and from choanae, about even with rear edge of latter.

Dorsal surface with a few large, scattered, round tubercles, somewhat more numerous in prescapular area where some are fused together; cranial skin free (juvenile characteristic?); dorsal surfaces of limbs tuberculate, as is chin and throat where the tubercles are prominently protuberant; skin on abdomen and ventral surfaces of thighs granular.

Foreleg of normal proportions; fingers three-fourths webbed (essentially as in *H. richardi* Taylor, 1952, Univ. Kans. Sci. Bull., 35: 819); finger pads somewhat wider than digits, which are broadly fringed; prepollex well defined but only very slightly free distally; a prominent, scalloped fringe along ventrolateral margin of lower foreleg, continuous onto outer finger but less well defined there.

Toes nearly fully webbed (essentially as in *H. richardi* as described by Taylor, *loc. cit.*); a well-defined inner metatarsal tubercle and fold; a small outer metatarsal tubercle; a conspicuous scalloped fringe along rear margin of tarsals and metatarsals, diminishing in prominence on fifth toe; a linear series of tubercles along dorsolateral edge of shank; heels overlapping with limbs folded and thighs at right angles to body axis; heel on adpressed limb reaching to eye; sacral diapophyses about twice as wide distally as at base.

Snout-vent, 22.5 mm.; head to rear of tympanum, 7 mm.; head width, 7.8 mm.; hind leg, 33 mm.; tibia, 11.8 mm.; width of finger pads, 1.2 mm.

Top of snout light tan, dorsal surfaces on body a grayer tan; a broad dark interorbital bar; a few scattered black spots in suprascapular region, covering one or more tubercles; other fewer and smaller black spots scattered on back; limbs prominently barred, especially hands, feet and thighs; finger pads dark; concealed surface of thigh lightly pigmented, partly barred; a prominent black streak across anus, bordered anteriorly by a narrow light streak continuous with light color on rear of thighs. Venter unmarked except chin and throat, which are dimly spotted. Fringes on fore and hind legs light.

Generic allocation. For about 70 years the only members known of this group were Boulenger's (1882, Cat. Batr. Sal. Brit. Mus.: 355-356, pl. 24, fig. 1) *Hyla tuberculosa* and Cope's (1886, Proc. Amer. Philos, Soc., 23; 272-273) *Hypsiboas miliarius* from Nicaragua. In 1943 Dunn (Caldasia, 8:309-311, fig. 1) described the third species, *Hyla phantasmagoria,* from Colombia. Taylor added three more species from Costa Rica in 1948 and 1952 (*H. richardi* and *H. fimbrimembra* in Copeia, 1948: 233-238, figs. 1-2; *H. immensa* in Univ. Kans. Sci. Bull., 35: 815-819, figs. 42-43). Curiously enough, all species of the group, including *H. valancifer,* are known only from the holotypes. The great rarity of the group presumably results in large part from its presumed restriction to the canopy of rain and cloud forests. The large size, rugose skin and fringed limbs may well be adaptations to the high rates of evaporation expected under such conditions, as has already been conjectured by Dunn (*loc. cit.*)

The similarity of the seven species in the *tuberculosa* group might well be attributed to convergence since the species occur in such disjunct areas. The common possession of a prepollex as well as the close agreement in habitus, size, skin texture and especially the form of limb fringes constitutes the strongest evidence of common origin. On the other hand Dunn regards certain species of the West Indies (*H. vasta* of Hispaniola, *H. lichenata* of Jamaica) as independently evolved, adaptive parallels of *H. phantasmagoria.* The West Indian species lack the prepollex but otherwise closely resemble the continental members of the *tuberculosa* group. Parallel and independent origin of the continental species is thus not ruled out.

Because of uncertainty of morphological limits we cannot here recognize a taxonomic grouping, generic or subgeneric, for the species here referred to the *tuberculosa* group. Taylor (1945, Proc. U. S. Nat. Mus., 95: 596) has already pointed out the previously overlooked fact that *Boana* Gray 1825 (Ann. Philos., n. s., 10: 214) is available for the quite similar group to which its monotype *(Rana boans* Linnaeus=*Hyla boans auctorum,* commonly but erroneously attributed to Daudin, 1803) belongs. Wagler's *Hypsiboas* 1828 (Nat. Syst. Amph.: 200) has as its genotype a species *(Hyla palmata* Daudin=*Rana maxima* Laurenti, now *Hyla maxima*) that is similar to *H. boans,* but unfortunately both of these species lack the distinctive fringes on the limbs so characteristic of the *tuberculosa* group. They seem to belong to Cochran's *faber* group (1955, Bull. U. S. Nat. Mus., 206: 66), or are closely allied thereto. The *tuberculosa* and *lichenata* groups may reasonably be regarded as parallel derivatives of ancestral types similar to living species of the *faber* group. At what level generic distinction from other groups of the present and unnaturally monstrous genus *Hyla* may be most advisable can properly be determined only by further anatomical studies. It is of interest to note in this connection that Dunn (*loc. cit.*) describes *H. phantasmagoria, H. crepitans* and *H. maxima* as having cylindrical sacral diapophyses, as may be regarded primitive in anurans, whereas at least a certain degree of dilation is commonly accepted as a generic feature of *Hyla.* A comparative study of this and other skeletal features among the species of *Hyla* might well provide the necessary clues for valid taxonomic subdivision.

It is curious, however, that both cylindrical (in *H. phantasmagoria*) and dilated (in *H. valancifer*) diapophyses may occur among members of such a seemingly closely-knit section as the *tuberculosa* group.

Comparisons. H. valancifer differs markedly from *H. immensa, H. phantasmagoria* and *H. tuberculosa* in lacking full webs between fingers. In passing it may be noted that the latter two names may be based upon a single species; *H. tuberculosa* is known from a single female (67 mm. snout-vent) from Río Cauca, border of Antiquia and Bolivar, Colombia. The descriptions available do not reveal differences that could not be attributed to sex or size, although on the basis of two specimens no view can be regarded conclusive.

H. richardi has a more sloping loreal region, *H. fimbrimembris* a more obtuse snout and less extensive webbing, and *H. miliaria* a longer leg (heel to tip of snout) than *H. valancifer*. The striking cross-barred pattern on limbs, the labial bars, and the spots on back and throat, seemingly distinguish *H. valancifer* from all other species of the group. Undoubtedly other differences equally as valid and of even greater key value exist, but they are overshadowed by the complete ignorance of individual, sexual and ontogenetic variation that exists in this group. Valid comparisons can now be made of very few characters—so few that a prospectively useful key to species cannot be made. The characters mentioned as distinguishing *H. valancifer* from others of the group are those that have seemed to us the least likely to be affected by anticipated variation.

Zoogeography. H. valancifer adds another to the growing list of endemic species of the San Martín area of southern Veracruz. The unusual herpetological interest of this area was first announced by the senior author in 1950 (Copeia, 2: 81-87) with description of the bizarre *Bufo cavifrons*. Wetmore (1943, Proc. U. S. Nat. Mus., 92: 215-240) had already pointed out the unique aspects of the bird fauna, and Leopold (1950, Ecology 31: 507-518) subsequently provided a brief analysis of the vegetation in a synoptic study of Mexico. These works as well as further field work by the senior author and by others persuaded to hasten the exploration have borne out the original convictions that the area about San Martin (1) represents one of the most sharply distinguished faunistic districts of Mexico; (2) is completely isolated ecologically from adjacent regions; (3) has a unique combination of environmental features; and (4) has functioned as a refuge for segments of paleassocies with which it was formerly in direct continuity.

The Catemacan Faunal District, as we here designate this area, is one of the smallest in Mexico. It embraces the Tuxtla range which extends about 50 miles in a northwest-southeast direction, and is perhaps 20 miles wide. It extends from an elevation of about 1200 feet to the highest peaks of 6165 feet. The District is characterized as follows: (1) it centers about isolated cloud forests above 4500 ft.; (2) it includes also a cold, high rain forest surrounding the cloud forest and extending down to elevations of about 1200 ft., reaching the edge of the village of Catemaco; (3) it receives an excessively high rainfall, maintained at a high

level throughout the year (data in press); and (4) a complete encirclement by natural savannas isolates it completely from all similar areas.

Substantiation of the validity of the Catemacan faunal disrict is to be found in every group of organisms yet studied in detail in this area. Since attention has but recently been focused on the area only a few groups have been at all well studied—the birds, reptiles, amphibians, and phalangids. Among reptiles and amphibians at least 8 endemic forms at the specific and subspecific levels have been reported or are now in press. In all these groups the Catemacan district marks the northern limits of some species, the southern limits of others. The higher elevations show clear affinities with the more northern Mexican plateau (*e. g. Thorius, Pseudoeurycea cephalica*) and at lower elevations more southern affinities are evident (*e. g. H. valancifer, H. ebraccata, H. phaeota*).

Perhaps because of the cool temperatures of the rain forest sector of the Catemacan district, a number of usually reliable cloud forest indicators among the vertebrates extend beyond their expected confines, some ranging through the rain forest. Acceptance of ecological range limits for any species in this district will require more than the usual minimum of supportive data. *Bufo cavifrons,* formerly thought to be a cloud forest species, is now known from the 400-meter level, and the same is true of various birds and plants (to be listed elsewhere by Tashian and Edwards). We accordingly do not conjecture that *H. valancifer* is limited to the cloud forest on the basis of the single known occurrence there.

The zoogeographic role of the Tuxtla range has seemingly been to serve as a refuge for certain specialized elements of the several paleobiota with which it must have been in direct continuity in the past—with the rain forests and cloud forests of the Mexican plateau and the rain forests of more southern regions. Its fortunate geographical position has permitted a relatively stable maintenance of high rainfall and moderate temperatures that on the contrary have not persisted in adjacent areas. The long isolation has been accompanied by extensive autochthony, but in effect the region may appropriately be thought of as an ecological or associational relict as defined by Simpson (1953, Major features of evolution: 305).

We are indebted to Diane Sank Firschein and Dr. Richard E. Tashian, members of the 1953 sojourn to San Martín; to Chester Lamb, collector extraordinary who gave much valued advice for our explorations; and to Dr. Clarence E. Goodnight who with the others here mentioned has contributed materially to an evaluation of the biogeographic status of the of the Catemaco district.

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The Reptiles and Amphibians of Korea

By FREDERICK A. SHANNON

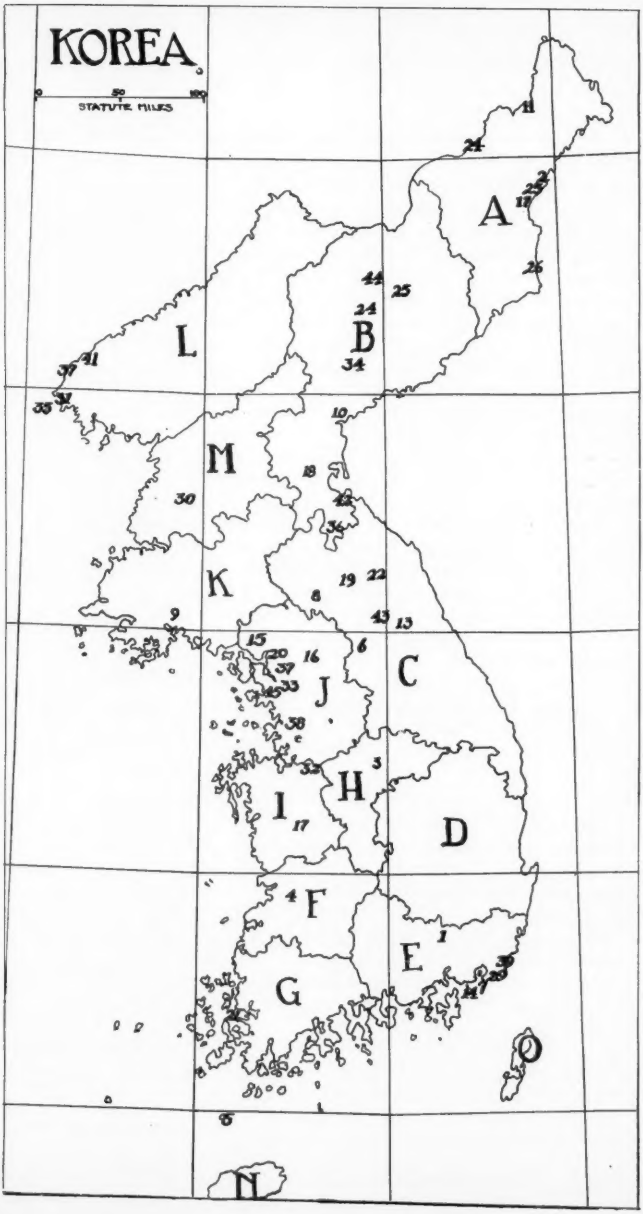
The author was stationed in Korea from August 10, 1951, to July 22, 1952, as surgeon for the 194th Engineer Combat Battalion. During this interval enough time was secured free from other duties to accumulate over 500 herpetological specimens representing 20 different species. Large numbers of undetected mines along the courses of mountain streams made collecting in these localities a rather foolish endeavor, so most of the material was secured from hillsides, plains, rice paddies, and the more frequented waterways where somewhat more careful mine-sweeping activities were practiced. In addition about 855 specimens of Korean reptiles and amphibians were examined from the collection of the California Academy of Sciences.

In this paper, thirty-seven species and subspecies of reptiles and amphibians are recognized, of which two are sea snakes and two are sea turtles. While a few may be later added or deleted, the above unimposing figure must not be far from the actual total.

A glance at a map of Asia will reveal Korea to be a rather small peninsula, leading one to expect that the herpetofauna would be nothing but an extension of Manchurian populations. This is largely true, as 25 of the 33 land species are found in both Korea and Manchuria. Two additional species are known only from their type localities, near Seoul, and may not be endemic. Of the remaining six species, two *(Rana)* are endemic, two *(Geoclemmys reevesi* and *Scincella reevesi)* are found both in China and Korea but are not definitely known from Manchuria, and two *(Gekko japonicus* and *Takydromus tachydromoides)* are doubtful invaders from Japan.

The mountains of northern and eastern Korea are extensions of the ranges in Manchuria and become progressively lower in altitude from north to south. The vegetation of the mountainous regions is similar to that of Manchuria and is classified by Berg (1950: 60, 322), as belonging to the Manchurian Broadleafed Forest, a branch of the Temperate Deciduous Forest. The characteristic cover of the lower and middle regions of the mountains is Korean pine *(Pinus koraiensis)*, Amur linden *(Tilia amurensis)*, Manchurian ash *(Fraxinus mandshurica)*, Manchurian fir *(Abies holophylla)*, Khingan fir *(Abies nephrolepis)*, Mongolian oak *(Quercus mongolica)*, mono maple *(Acer mono)*, Scotch elm *(Ulmus montana heterophylla)* and others. Higher in the mountains the deciduous forest and Korean pine give away to fir and Yeddo spruce *(Picea jezoensis)*. Flood-plain forest is similar to that described for the lower mountain slopes and contains Manchurian walnut *(Juglans mandshurica)* and Mongolian poplar *(Populus suaveolens)* as well. This forest is similar to European mixed forests and the deciduous forests of eastern United States, differing in closely related species.

In Manchuria, as in the Caucasus, southern Europe, and eastern United States, relict faunas and floras from Tertiary glaciation represent the more widespread pre-glaciation species. The Manuchurian Broadleafed Forest was the successor to the East Asian Element of the Hardwood-Deciduous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Complex (Arcto-Tertiary) of Axelrod (1950: 7), the other elements being the East American and the Caucasian.

Okada (1931: 2) lists the northern part of Korea, Hokkaido, Sakhalin, and the Kuriles as being in the Siberian Subregion of the Palarctic Region. He lists the southwestern part of Korea and the rest of Japan as being parts of the Manchurian Subregion.

One of the most frustrating problems in the attempt to correctly allocate Korean specimens has been the liberal use in the literature of numerous synonymous names for almost every Korean locality. These names are in romanji, Japanese, in Korean (phonetically transliterated, of course, in an intriguing variety of manners), and in a number of other dialects of bastard origin beyond personal comprehension. The author has done little toward consistency in choice, but a map has been prepared with the localities mentioned in the paper recorded as numerals (See Text Fig 1). The provinces and two important islands are recorded as letters. The legend for the map also includes localities that could be traced only to province and a few that could not be allocated at all. Occasional localities have been determined with considerable hesitation. Thus Zae-zu-to was interpreted to refer to Ch'uja Do, off the coast of Cholla Namdo. This interpretation may be incorrect as to locality, although correct as to province. Slevin's paper (1925) on Korea refers to specimens collected by Thompson at "Sagawansa." Thompson was at "Sagawansa" on June 8, 1911, after collecting at Wonsan on June 7. He did no collecting on June 9 and could have done little with his time except to cross the peninsula to the southwest. From the speed with which this was done he must have used the railroad. On July 10 he was collecting at Ch'ongju (Ch'ungch'ong Pukto). The only likely locality along this hypothetical route which could be correlated with "Sagawansa" is Songhwon in southern Kyanggi Do. In some instances difficulties have been encountered in duplication or resemblance of names. There is a "Ch'ongju" in Ch'ungch'ong Pukto, another in P'yongan Pukto, and a Chonju in Cholla Pukto.

KOREAN PROVINCES

A. Hamgyong Pukto (Kankyo Hokudo)
B. Hamgyong Namdo (Kankyo Nando)
C. Kangwon Do (Kogen Do)
D. Kyongsang Pukto (Keisho Hokudo)
E. Kyongsang Namdo (Keisho Nando)
F. Cholla Pukto (Zenra Hokudo)
G. Cholla Namdo (Zenra Nando)
H. Ch'ungch'ong Pukto (Chusei Hokudo)
I. Ch'ungch'ong Namdo (Chusei Nando)
J. Kyonggi Do (Keiki Do)
K. Hwanghae Do (Kokai Do)
L. P'yongan Pukto (Heian Hokudo)
M. P'yongan Namdo (Heian Nando)
N. Quelpart Island
O. Tsushima Island

Fig. 1. Map of Korea: lettered provinces and numbered collecting localities correspond to list in text.

KOREAN LOCALITIES

1. Ch'ongnyong (Chang-won)
2. Ch'ongjin (Seishin)
3. Ch'ongju (Seishu)
4. Chonju (Zun-Zu, Zan-Nu)
5. Ch'uja Do (Shushi to, Zae-zu-to)
6. Ch'unch'on (Shunsen)
7. Choryong-do
8. Ch'orwon (Tetsugen)
9. Haeju (Kaishu, Hae Zu, Hap-su)
10. Hamhung (Kanko, Sei-ko-shin)
11. Hoeryong (Kainei, Kwainei)
12. Inch'on
13. Inje
14. Kadok-to (Ka-tuk-to) Island north of Koje-do.
15. Kaesong (Songdo, Kaijo)
16. Kapyong
17. Konju (Koshu)
18. Kowan (Kangozan, also Kongo Peak at Kowan)
19. Kumhwa
20. Kyongsong (Kyojo, Kyung-sung)
21. Mokp'o (Moppo)
22. Mundung-ni
23. Munsan-ni
24. Musan Pass—on Yalu River
25. Nanam (La Nam, La Tlam)
26. Po'ha-dong (Pochondong, Hosando, Hozando)
27. Puksubaek-san (Buk-ke Su)
28. P'ungsan
29. Pusan (Fusan)
30. P'yongyang (Heijo)
31. Sampoto
32. Seikan
33. Seoul (Kyongsong, Keijo)
34. Shoko
35. Sin-do (Su-un-to, Suiunto, Shin-to)
36. Sin'gosan (Shinkozan)
37. Sinuiju (Shingishu, Shi-i-zu)
38. Suigen (Chicksan, Chickusan, Keidi, Yonggu, Yoshu, Suwon, Sung-Fan)
39. Tongnae (Torai)
40. Uijongbu (Uijonbu)
41. Uiju (Ujo)
42. Wonsan (Genzan, Gensan)
43. Yanggu
44. Yangp'yong-ni
45. Yongdung-Po (Eitoho)
46. Yongamp'o (Ryuganpo, Ryugampo). Locality too close to 31 to plot.

LOCALITIES IDENTIFIABLE ONLY TO PROVINCE

Kwang-nung: Kyonggi Do
Mt. Kwanak: Kyonggi Do
Mt. Zung-bang: Hwanghae Do
Paek-a: Kyonggi Do (Island)
Pu-Ryong: Hamgyong Namdo
Ra-Buk or La Buk: Hamgyong Pukto
Sagawansa: Probably Songhwon in southern Kyonggi Do.

LOCALITIES UNIDENTIFIABLE EVEN TO PROVINCE

Komazan
Rahoku

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KEY TO THE REPTILES AND AMPHIBIANS OF KOREA
(Adapted in part from Pope, 1935 and 1940)

Key to the Caudata (Hynobiidae)

1a. Lungs present; no claws; vomerine teeth in V-shaped series..... *Hynobius* (2).
b. Lungs absent; claws always present in juveniles; teeth in nearly straight line..... *Onychodactylus fischeri.*
2a. Five toes; pattern basically black mottled with light brown; no light dorsal stripe..... *Hynobius l. leechi.*
b. Four toes; light dorsal band present..... *Hynobius keyserlingi**.

Key to the genera and species of Salientia

1a. Abdomen vividly marbled with brick red and dark (may be yellow in preservative) ..... *Bombina orientalis.*
b. Abdomen may be varicolored, but not as above..... 2.
2a. A large dermal gland (parotoid) present on each side of body behind head; skin warty and rough..... *Bufo bufo gargarizans.*
b. Skin rough or smooth, but parotoid glands absent..... 3.
3a. Form spherical; head minute, much narrower than (less than 1/3) body width..... *Kaloula borealis.*
b. Form elongate or broadened, but not spherical in contour; head elongate, much wider than 1/3 body width..... 4.
4a. Intercalary cartilage present in fingers; terminal discs considerably wider than phalanges..... *Hyla arborea japonica.*
b. Intercalary cartilage absent; phalangeal tips not as wide as phalanges ..... *Rana* (5).
5a. Elongate dorsolateral ridges absent; dorsum extremely rough with rugosities consisting of short, elongate ridges..... *Rana rugosa.*
b. Elongate dorsolateral ridges present; dorsum rough or rather smooth ..... 6.
6a. Heels not or barely overlapping; canthus rostrals indistinct..... 7.
b. Heels broadly overlapping; canthus rostralis distinct..... 8.
7a. Narrow dorsolateral fold; short elongate ridges between folds ..... *Rana nigromaculata.*
b. Extremely wide dorsolateral fold; pustules distinct or indistinct between folds, but not elongate..... *Rana plancyi chosenica.*
8a. A pair of paravertebral stripes (may be broken but always present); vocal ostia and vocal sacs absent in males; dorsolateral ridges nearly straight or flaring slightly behind head..... *Rana amurensis coreana.*
b. Paravertebral stripes absent: vocal ostia and vocal sacs present in males; dorsolateral ridges usually with considerable flare in tympanal region..... *Rana temporaria dybowski.*

Key to the Turtles.

1a. Large, with anterior extremities modified into large, broad paddles; found in the sea..... 2.
b. Small, with anterior extremities not modified into large, broad paddles; never found in the sea..... 3.
2a. Limbs clawless; carapace with seven prominent longitudinal ridges ..... *Dermochelys coriacea schlegeli.*

*No definite records from Korea, but probably present in the northern part of the country.

b. Limbs with one or more claws; carapace without seven longitudinal ridges.....*Chelonia mydas japonica.*
3a. Shell covered with horny shields.....*Geoclemmys reevesi.*
b. Shell covered with soft skin.....*Amyda sinensis.*

Key to the Lizards.

1a. No large, symmetrical shields on dorsum of head; eyelids immovable .....*Gekko japonicus.*
b. Large, symmetrical shields on dorsum of head; eyelids movable.... 2.
2a. Ventral scales cycloid, resembling those of sides and back; femoral and inguinal pores absent..... 3.
b. Ventral scales squarish, sharply differentiated from lateral; femoral or inguinal pores present..... 4.
3a. Lower eyelid opaque.....*Eumeces coreensis.*
b. Lower eyelid with an undivided, transparent disc.....*Scincella reevesi.*
4a. Dorsal scales granular, not keeled.....*Eremias argus.*
b. Dorsal scales strongly keeled, not granular.....*Takydromus* (5).
5a. Three pairs of chinshields.....*Takydromus auroralis.*
b. Four pairs of chinshields..... 6.
6a. One femoral pore on each side.....*Takydromus wolteri.*
b. More than one femoral pore on each side..... 7.
7a. Two (rarely three) femoral pores on each side, not more than six rows of dorsal scales.....*Takydromus tachydromoides.*
b. Three or four femoral pores on each side, six or eight rows of enlarged dorsal scales..... 8.
8a. Three femoral pores on each side, eight rows of enlarged dorsal scales.....*Takydromus amurensis.*
b. Four femoral pores on each side, six (occasionally seven) rows of enlarged dorsal scales.....*Takydromus kwangakensis.*

Key to the Snakes.

1a. Tail laterally compressed; marine.....*Hydrophiidae* (2).
b. Tail round; not marine..... 3.
2a. Ventrals small but distinct throughout, not divided by a median suture.....*Hydrophis melanocephalus.*
b. Ventrals much reduced in size or absent or divided by a median suture.....*Pelamis platurus.*
3a. Maxillary short, vertically erectile, bearing long perforated fangs.. 4.
b. Maxillary horizontal, not erectile; fangs absent..... 5.
4a. Loreal pit present.....*Ancistrodon halys brevicaudus.*
b. Loreal pit absent.....*Vipera berus sachalinensis.*
5a. Color black with red crossbands; loreal usually enters eye..... .....*Dinodon rufozonatum.*
b. Color other than black with red crossbands; loreal separated from eye by preoculars..... 6.
6a. A conspicuous, black-edged, yellow, middorsal stripe extending from head throughout length of body; scales in 17 rows around middle of body.....*Zamenis spinalis.*
b. No middorsal yellow stripe; scales in more than 17 rows around middle of body..... 7.
7a. Scales strongly keeled; scale rows 19..... 8.
b. Scales weakly keeled or smooth; scale rows more than 19..... 9.

8a. Ground color essentially green with narrow red interspaces anteriorly; preoculars two.....*Natrix tigrina lateralis.*
b. Ground color not green with red interspaces; one preocular.....*Natrix vibakari ruthveni.*
9a. Scales in 21 rows at midbody; scales smooth.....*Elaphe rufodorsata.*
b. Scales in more than 21 rows at midbody; scales weakly keeled.....10.
10a. Tail with four black and four white longitudinal stripes.....*Elaphe taeniurus.*
b. Tail without four black and four white longitudinal stripes.....11.
11a. Scales in 25 (rarely only 23) rows; ventrals usually less than 205; narrow crossbands on body.....*Elaphe dione.*
b. Scales in 23 or 21 rows; ventrals usually 206 or more; blotches, if present, are wide.....12.
12a. Adults with dorsal blotches faint, or dorsum uniformly brown; postocular stripe indistinct or absent; ventral spotting reduced or absent.....*Elaphe schrenki anomala.*
b. Adults with contrasting dark dorsal blotches; postocular stripe distinct; profuse ventral spotting (juveniles cannot be easily distinguished from 12a).....*Elaphe schrenki schrenki*

Family Hynobiidae

Hynobius leechi Boulenger.

1887. *Hynobius leechii* Boulenger, Ann. Mag. Nat. Hist., ser. 5, v. 19, p. 67. Type: Brit. Mus. 86.12.8.14. Type locality: "Gensan" (Wonsan), Korea.

One hundred forty-one specimens from Pusan were examined at the California Academy of Sciences. The basic pattern is black mottled with light brown dorsally. There is no sign of a caudal fin present in adults.

Stewart (1953: 148) has collected the salamanders from 5.8 miles SW of Inje, where they were taken from a stream pool. Other localities from the literature are Suigen, Kongju, and Wonsan.

It seems likely that *Hynobius keyserlingi* should be added to the fauna of Korea. Professor Cho of the University of Seoul states that this amphibian does penetrate Korea from Manchuria.

Onychodactylus fischeri (Boulenger).

No specimens of this species of clawed salamander were taken in the field. Four adults and 220 juveniles from Wonsan belonging to the California Academy of Sciences were examined by the author. Professor Cho (letter) states that the salamander has also been collected from Haeju.

Numerous juveniles in the CAS collection have a broad, cream-colored dorsal stripe. In a few the cream is longitudinally divided by a line of dark brown vertebral pigmentation. Claws, absent in all four adults, were invariably present in the juveniles.

Family Discoglossidae

Bombina orientalis (Boulenger).

1890. *Bombinator orientalis* Boulenger, Ann. Mag. Nat. Hist., (6) V, p. 143. Type locality: Seoul, Korea.

Over 100 specimens, largely from Seoul, from 50 miles NNE of Seoul, and from the vicinities of Kumhwa and Ch'orwon were taken in 1951 and 1952. The favorite location for these weak-bodied little am-

phibians was vegetation-choked marshes containing a few inches of water They were common in rice paddies and could be found in the grass margining larger bodies of quiet water but were not found near running water. Stewart (1953: 146) found that they were common along the edges of streams near Inje. They were observed in amplexis in late April and early May and again in late August and early September. The copulating couples were floating in shallow water, although many found buoyant support in the thick vegetation or on the shallow bottom of their marsh or pond. In their habitat they were abundant and could be collected in unlimited numbers. Eggs and tadpoles were observed in late August.

An abundant milky secretion given off by secretory glands in the rough skin of these salamanders is extremely irritating to lips, nostrils, and eyes. It exerts a histaminic effect with a profuse consequent vasomotor rhinitis accompanied by lachrimation. Several *R. n. nigromaculata* carried in the same bag with the *Bombina* were found to be dead after the lapse of an hour.

The exact localities of 66 specimens of the above series are: 8 mi E Ch'orwon, FAS 4373-76; 16 mi S Ch'orwon, FAS 4312, 4316, 4319-4344, 4473; 9 mi E Kapyong, 4313-15, 4318, 4346-48, 4350-51, 4353-56, 4358-64, 4368-72; 4 mi E Kapyong, 4357; near Kapyong, 4317, 4344, 4349, 4352; 23 mi. SE Kumhwa, 4365-67. The toads were seen until the middle of October, 1951. The first to be collected in 1952 was on April 29. Other localities from which *Bombina* has been collected are: 5.8 mi SW Inje, 7 mi NNE Yanggu, Pusan, Hoeryong, Nanam, Musan, Ch'ongyong, Tongnae, Kadok-to, Chonju, Kaesong, Suigen, Ch'uja Do.

Family Bufonidae

Bufo bufo gargarizans Cantor.

1842. *Bufo gargarizans* Cantor, 1842, Ann. Mag. Nat. Hist., (1) 9: 483. Type locality: Chusan Island, China.

1869. *Bufo vulgaris* var. *asiatica* Steindacher, 1869, Novara Exped. Zool., 1, Amph., p. 39. Type locality: Shanghai, China.

Nine specimens (FAS 4303-11) were collected 8 miles south of Ch'orwon during May and June, 1952. Another (FAS 4377) from Seoul was presented by Professor Cho.

The toads, far from abundant, were taken hopping around the hills near camp. During a heavy rain they would occasionally enter the tents in an attempt to avoid the excessive moisture.

Schmidt (1927: 557) believes that *gargarizans* of Chusan Island is the same as the mainland population known as *asiatica*. This has been supported by numerous other authors, and it seems likely that *asiatica* should be regarded only as a junior synonym of *gargarizans*.

Okada (1931: 47) states that the toad is not native to Korea but has been widely introduced.

The toad has also been collected from P'yongyang, Tongnae, Munsan-ni, Wonsan, Kongju, and Pusan.

Family Hylidae

Hyla arborea japonica Guenther.

1858. *Hyla viridis* var. *japonica* Guenther, Cat. Batr. Sal. Brit. Mus., p. 81.

1858. *Hyla arborea* var. *japonica* Guenther, Cat. Batr. Sal. Brit. Mus., p. 109. Type locality: Japan.

1887. *Hyla arborea* var. *savignyi* Boulenger, Ann. Mag. Nat. Hist., (5), 19, p. 67 (part). From Gensan (Wonsan), Korea.

1887. *Hyla stepheni* Boulenger, Proc. Zool. Soc. London, p. 579, pl. 51, fig. 1. Type locality: Port Hamilton Island, Korea.

1888. *Hyla chinensis* var. *immaculata* Boettger, Ber. Senckenberg Naturf. Ges., Abh., p. 189. Type locality: Shanghai.

1918. *Hyla arborea ussuriensis* Nikolsky, Amphibia (in *Faune de la Russie et des Pays limitrophes*) 309 pp., pl. 1-4, 62 figs., Petrograd.

1931. *Hyla arborea stepheni* Okada, The tailless batrachians of the Japanese Empire, pp. 63-64, Seoul, Korea.

1940. *Hyla arborea immaculata* Pope and Boring, Peking Nat. Hist. Bull., v. 15, pt. 1, p. 35.

Over 50 of these little *Hyla* (37 of which are here reported) were taken from Seoul (FAS 4576-4582); from 41 mi NNE of Seoul (FAS 4557-4575); from the vicinity of the base camp 8 mi. S Ch'orwon (FAS 4556, 4583-92). Following a light rain on the night of May 18, 1952, a series of *Hyla* came from the green hills of the Ch'orwon camp and were trapped in foxholes between the hills and the stream below. The following passage is taken directly from field notes:

> "Grass green above and white below, with blood-colored venter around posterior portion of abdomen and ventral surfaces of femur. Blotching above greyish-black, abundant to nearly absent. Brownish-black stripe from nose thru eye to mid-body, bordered above with white. Dark femur banding strong to nearly absent. Green ground color may be replaced by gray."

Between 8:30 and 10:00 P.M. on the night of June 29, 1952, *Hyla* were heard calling from a rice paddy near the Ch'orwon camp. The call consisted of a "rik-rik-rik-rik-rik," repeated 7 or 8 times in a sharp treble and followed by a considerable rest. It was raining and had been raining for the preceding 36 hours. The amphibians were found clinging to the stems of grass or other low-growing vegetation in the shallow water or in damp matted vegetation just above the water.

Description (FAS No. 4574, adult male from 8 mi S Ch'orwon, collected June 29, 1952). Head broader than long; tympanum round, distinct, diameter slightly greater than ½ that of eye, superior border buried beneath a distinct tympanal fold starting at posterior corner of eye to angulate behind tympanum, terminating slightly behind corner of mouth and above insertion of arm; canthus distinct; nostrils just beneath canthus, distinct, open dorsally; snout rounded. Tongue fleshy, rounded, attached in front, free to sides and rear, notched posteriorly; vocal ostia elongate, extending from side of tongue posteriorly to near angle of mouth; vomerine teeth in two patches angulating slightly posteriorly, closer to each other than choanae; choanae large, distinct, lying on each side of vomerine teeth.

Skin of dorsum loose, smooth, leathery; a few discrete, large pustules behind angle of mouth and above anus; anus transverse and dorsally placed. A slight but distinct fringe of web at base of all fingers; digital formula 3-4-2-1; thenar tubercle elongate, distinct; hypothenar and palmar tubercles indistinct, tending to be replaced by strongly developed pustules present over the whole palm; subarticular tubercles single, strongly developed; discs distinct but only slightly wider than toes. Legs separated by two millimeter gap when shanks are adpressed to thighs; extended tibiotarsal joint to middle of eye, tarsal fold strong, extending from medial metatarsal tubercle to ankle; medial metatarsal tubercle elongate, distinct; lateral metatarsal tubercle punctuate; sole strongly pustular; subarticular tubercles single, distinct; digital formula 4-3-5-2-1; toes slightly less than 2/3 webbed; discs little wider than toes.

Ventral surfaces pebbly, especially on chest, abdomen, and femoral surfaces and beneath anus. Pebbly surfaces of chin give away to a slightly smoother, loose, prominent vocal pouch.

Measurements of specimen in millimeters. Snout-vent, 33; head width, 12.8; head length, 10.2; diameter of tympanum, 2.4; diameter of eye, 4.2; from eye to nostril, 3.4; internasal, 3.1; interorbital, 4.3; vocal ostia, 4.5; diameter of 3rd finger disc, 1.5; smallest diameter of 3rd finger, 1.1; femur, 15.7; tibia, 16.1; foot, 14.5; inner metatarsal tubercle length, 2.0; length of first toe, 3.8.

Color of specimen in alcohol. Dorsal ground color dark bluish-gray with large, roughly paired, darker, irregularly shaped dorsal blotches; dark spot beneath eye on upper labium; dark stripe bordered above with light from nostril to eye, and from eye to above tympanum, thence to side of body where it gradually tapers out before groin. Pigment on thighs confined to a dark, quite distinct, narrow band; thighs banded in the sense that the bands are confined to the width of the longitudinal femoral band; arms banded; tibial and tarsal surfaces banded. Ground color of venter and sides cream, with brown staining evident on chin and sides.

Variation in 33 other specimens from near Ch'orwon and from Seoul. Ten of these Hyla had an inner metatarsal tubercle in excess of 66% of the length of the first toe, the average tubercle length being 60% (43.5-75.0); outer metatarsal tubercle present in all; 5th toe from 1/3-2/3 webbed, average slightly over ½; fingers webbed at base in all. There is a considerable variation in color pattern, but it should be remembered that specimens in formaldehyde may almost completely lose the dorsal spots which may be quite evident in living specimens. The dorsal spots may vary considerably in intensity on the same specimen, depending upon the amount of exposure to light. The above series varied from specimens having distinct spots with banding on the arms and legs and with lateral stripes to those lacking in all these characters. Pattern reduction was not necessarily consistent; some had arm and leg banding only, spots only, or lateral bands only, as well as every conceivable variation in pattern structure. The lateral band was usually present.

If the above remarks have been painfully elaborate, they will at least indicate why it has been found necessary to apply the same name to the Chinese, Japanese, and Korean populations. *Hyla stepheni* was described from Port Hamilton, just to the south of Korea, in 1887 as occurring with *Hyla a. japonica.* The only distinguishing characteristic of Boulen-

ger's (*op. cit.*) description was "inner metatarsal tubercle large and very prominent, oval, about two-thirds the length of the inner toe." As may be seen above, this character is useless in differentiating the Korean population. Boulenger later (1890) records two specimens from the Ussuri River as *stepheni,* stating that the species "is easily distinguished from *H. arborea* by the much larger and more prominent metatarsal tubercle." The length of the first toe is given as 4 mm. and that of the inner metatarsal tubercle as 2.5 mm. (FAS 4559 from 46 mi NE Seoul has a first toe length of 3.8 mm. and a tubercle length of 2.5 mm.) Unfortunately, the type of *H. stepheni* is so dessicated that it is useless. Pope and Boring (*loc. cit.*) state that *Hyla arborea immaculata* occurs in northern China as well as in the Shanghai Valley where it was originally described in 1888. They state that *immaculata* from "Anhwei have a color pattern more closely resembling that of individuals from Germany than do Japanese specimens." Unfortunately, they do not state in what way it is different and *immaculata* may be far from immaculate, whereas specimens from both Korea and Japan may be quite lacking in dorsal pattern. Pope and Boring feel that *stepheni* cannot be differentiated from *immaculata* and, apparently due to a *lapsus* since *stepheni* was described first, throw *stepheni* into the synonomy of *immaculata.* They also synonomize Nikolsky's (1918) *Hyla arborea ussuriensis* from the Russian Coast Province adjacent to Manchuria. It is doubtful if Boettger (1894) is correct in stating that japonica has toes ½ and ¼ webbed, whereas *immaculata* has no finger webbing and toes ¼ webbed.

While good characters may exist which will serve to subspecifically differentiate these populations, I have no alternative to listing all as *H. a. japonica* until such characters have been adequately demonstrated.

These little tree toads have also been collected from Munsan-ni, Pusan, Wonsan, Kongju, Hamhung, Wonsan, P'yongyang, Rahoku, Hoeryong, Seoul, Tongnae, Suigen, Pyongyang, Nanam, and La-Buk.

Family Microhylidae

Kaloula borealis (Barbour).

1908. *Cacopoides borealis* Barbour, Bull. Mus. Comp. Zool., Harvard, 51, p. 321. Type locality: Antung, Manchuria.

1913. *Callula tornieri* Voigt, Sitzber. Ges. Natf. Fr. Berlin, p. 219. Type locality: Korea.

1934. *Kalowla borealis* Parker, A monograph of the frogs of the family *Michrohylidae,* p. 82.

These microhylids were dug out of mammal burrows in the vicinity of Yongdung'po, Korea (FAS 4546) by Col. Robert Traub, on May 9, 1952. Eleven more (9 of which are FAS 4547-55) were collected by Sgt. Harman and myself from a rice paddy 8 mi S Ch'orwon on June 29, 1952. Although they had been hunted persistently above ground before this latter date, none had been seen. There had been a steady, 36-hour rain previous to the night of June 29, and the toads had been heard on the preceding evening. The collecting was done between 8:30 and 10:00 P.M. with the rain still steadily falling. The air and water temperatures were 70°F. and the calling males were scattered through the rice paddy. A few individuals called with a sound of "wreck-wreck," although the more common sound was "urrh-urrh-urrh." The latter sound ended in an

explosive grunt pitched in a low bass and lasting about ½ second, separated by a pause of ½ second or less. Several calls were heard at a time, followed by a longer pause of several seconds. The toads were hard to find as they were sitting beneath broad-leafed plants in two or three inches of water. The call was pinpointed by triangulation with two flashlights. When picked up, the little toads would inhale large quantities of air, becoming extremely inflated.

The living specimens were dark olive-brown. Areas of yellow punctations appeared in the dorsal pattern (xanthochromes?) and these frequently turned brown. A copious light secretion given off by handled specimens would quickly assume the consistency and texture of rubber cement. The secretion was quite sticky, had a bitter taste, and quickly numbed the tip of the tongue.

This microhylid is reputed to occur only in the southwestern part of Korea. Other locality records are Seoul (FAS 4547) Suigen, Seikan, and Ch'uja Do.

Family Ranidae

Rana rugosa Schlegel.

About 60 specimens were collected by the author and by other members of the 194th Combat Battalion during the fall of 1951 and the spring of 1952. Most of the specimens were taken in the vicinity of Kumhwa or Ch'orwon. They appear in small numbers on the warmer days of March and are out in force by middle April, being found on the banks of running water. They are quite cautious and when approached will dive into the clear water where they sit crouched on the rocky bottom. If further disturbed they swim beneath rocks to hide. Their salt-and-pepper gray marking affords a high degree of protective coloration, and some difficulty may be experienced differentiating them from the rocks. Although the banks upon which they sit may be grassy, they seldom try to hide in the vegetation. They may be found until the end of November or the early part of December on warm days.

This frog is reported from most of Korea. It is reputed to be rare, but from our own observations it seems to be one of the most common amphibians in central Korea. Forty-three of the above series are recorded as follows: 4 mi E Kapyong, FAS 4481-82, 4484-86, 4488; 8 mi E Kapyong, FAS 4483; 9 mi E Kapyong, FAS 4487; 26 mi SSE Kumhwa, FAS 4489; 23 mi S Kumhwa, FAS 4490-4500, 4506-07, 4516-19; 4 mi N Ch'orwon, FAS 4503-4, 4514-15; 6 mi S Ch'orwon, FAS 4502; 8 mi S Ch'orwon, FAS 4505, 4513; 9 mi S Ch'orwon, FAS 4501; 10 mi S Ch'orwon (Hantan Ch'on River), FAS 4508-12, 4520-24. The frogs have also been collected from 5.8 mi SW Inje, Pusan, Kaesong, Nanam, Tongnae, and Ch'uja Do.

Rana nigromaculata Hallowell.

1860. *Rana nigromaculata* Hallowell, Proc. Phil. Acad. Sci., p. 500. Type No. 152, Tokyo Imp. Univ., from Ofuna, Kanagawa Prefecture, Japan.

Nearly 150 specimens (FAS Nos. 4380-4772, 4474-80, 4546 plus others) were secured from 50 mi ENE of Seoul, from Seoul, and from the vicinities of Kumhwa and Ch'orwon.

Between 1:00 and 4:00 P.M. on the afternoon of April 14, 1952,

several of these frogs were seen in a rice paddy and creek, 8 mi S Ch'orwon. The air temperature was 58-60° F. The high temperature of the shallow water at the edge of the rice paddy of 62-68° F. was probably due to decomposing vegetation. The temperature of the deep water and of the creek was about 56° F. The frogs were in the grass and in rice stumps, submerged except for their noses. The call was gutteral to clucking, sometimes a little resonant: "urr-curr-curr-eh-keh-keh-uh-kuk-kuk-uh-kuk-kuk." The calls were of 1 to 3 seconds duration and were infrequent. The frogs were extremely wary and those surprised out of water would escape by writhing rapidly through the dense grass, with only occasional high jumps. The paddy was revisited at 8:00 P.M. At that time the air temperature was about 50° F. The frogs were calling from all parts of the paddy. Where the water temperature was 52° F. the frogs were more scarce and when surprised would only submerge to lie on the rice stumps. Where the water temperature was 54° F. the frogs would submerge, then dive under the stumps. Floating free in the water, the males would call "churruh-churruh-churruh," the call frequently lasting four to five seconds. On the night of April 24 (9-10:30 P.M.) the air temperature was 57° F. and the water 56-58° F. Captured frogs were either greenish-gold, usually with distinct pale green dorsal strips and a few posterodorsal spots, or they were vivid grass green with indistinct lighter stripes and distinct posterior black spots. A clutch of eggs was taken at 10:30 in a small pool which had been collected at 9:00 P.M. At the earlier time 12 frogs were there but the eggs were not. At that time none of the frogs were in amplexus although one evaded a jump from another. The eggs were about six inches beneath the surface and were attached in one large clump to rice stalks. The animal pole was perhaps slightly smaller than the vegetal although in a few eggs it was as large as or larger than the latter. No cleavage was present. The individual eggs were 2 mm. in diameter. Two envelopes appeared to be present, the outer about 3 to 3½ mm. in diameter. By 8:30 the following morning all eggs had the first cleavage plane in 60° F. water and about 1/3 had the second. By 9:00 the following morning they were entering the blastula stage. By 10:00 A.M. on the 28th the neural ridge was evident, and by that evening it was closed in many. The eggs were accidentally destroyed on the 30th. At that time early tail formation was evident.

The frogs were collected until early November of 1951. They reappeared by the middle of April of 1952.

There has been considerable debate as to the authenticity of Schmidt's (1927) division of the species into three Chinese subspecies. Pope and Boring (1940: 55) conclude that the division was not valid, and Liu (1950: 309) tentatively follows Pope and Boring. It is doubtful if the Korean population could be separated from the Chinese, unless it were on the plains of south Korea, as the species is only an insular extension from Manchuria.

Exact localities for the above mentioned specimens are: 4 mi N Ch'orwon, FAS Nos. 4391, 4397-98, 4470, 4475-77; 6 mi S Ch'orwon, 4382, 4428; 8 mi S Ch'orwon, 4380-81, 4387-89, 4392-93, 4401-2, 4404-08, 4411, 4413-15, 4417-23, 4429-30, 4432, 4440-53, 4459, 4461, 4463, 4465-69, 4472, 4474, 4479-80; 9.5 mi S Ch'orwon, 4394-95, 4416; 10 mi S Ch'orwon (Hantan Ch'on River), 4383, 4403, 4412, 4431, 4454-

58; 13 mi S Ch'orwon, 4396, 4462; 2 mi W Kapyong, 4385-86, 4424, 4426; 4 mi E Kapyong, 4384, 4399, 4433-35; Kumhwa, 4471; 5 mi S Kumhwa, 4478; 23 mi S Kumhwa, 4390, 4400, 4546; 21 mi SE Kumhwa, 4410; 23 mi SE Kumhwa, 4425, 4436-39; 51 mi NNE Seoul, 4409; Seoul, 4427, 4460; Yongdung'po, 4464. Other recorded localities are: 5.8 mi SW Inje; 4 mi E Yangp'yong-ni near Munsan-ni; Ch'ongjin; Pusan, Kongju, Hoeryong, Wonsan, Sagawansa, Hamhung.

Rana plancyi chosenica Okada new combination.

1931. *Rana nigromaculata chosenica* Okada, The tailless batrachians of Japan, p. 89, pl. 8, fig. 1. Type locality: Seoul, Korea.

1926. *Rana nigromaculata coreana* Okada, Annot. Zool. Japan, v. 11, no. 42, p. 100. (nec *Rana temporaria coreana* Okada, same paper, p. 97.)

1925. *Rana plancyi* Slevin, Proc. Cal. Acad. Sci., 4th ser., v. 14, no. 5, p. 92.

While only 11 specimens of the two subspecies of *R. plancyi* (7 from Korea and 4 from Shanghai, China) were examined, these specimens could invariably be differentiated on the basis of color. In addition, descriptions gleaned from the literature as well as published illustrations (Okada, 1941, pl. 8, figs. 1 and 2) bear out the differences of the material on hand.

Diagnosis. *R. p. chosenica* may be differentiated from *R. p. plancyi* by the presence in the former of a rather uniform green groundcolor (gray in preservative) on the posterior aspect of the thighs; similar area of *plancyi* is cream, mottled with dark. Morphological differences are minor. The web between the toes of the Korean subspecies is more incised and is not quite as extensive as that of the Chinese subspecies. This is most noticeable on the first toe of *chosenica*, where the web extends to the proximal 1/3 or ½ of the terminal phalanx whereas the first toe of Chinese *plancyi* is fully webbed. There is little doubt that examination of larger numbers of well-preserved specimens will reveal that there is a significant difference in the amount of dorsal pustulation, the Korean subspecies being quite pustular and the Chinese relatively smooth.

Variation. Occasional specimens of *chosenica* may have scattered dark spots on the posterior aspect of the thighs. While these specimens are superficially similar to *plancyi*, their dark spots are not on a cream background as they are in *plancyi* and the spotting does not assume the complex marbling present in *plancyi*, where the cream groundcolor may itself be broken into spots by reticulation of the darker color. Complex cream and dark reticulation on the lateral surfaces of the body of *plancyi* is greatly reduced or absent in *chosenica*. Both subspecies have a black band bordered by a light band on the posteroventral aspect of the thigh. The light border is much better developed in the Chinese population and extends onto the upper surfaces of the thigh, as the yellow groundcolor already discussed. The band may be greatly reduced in Korean specimens.

R. p. chosenica is confined to southern Korea and occurs over the same general range as *R. a. coreana*. It may be found in lesser numbers in the same rice paddies and ponds as *R. n. nigromaculata*, with which species it has often been confused.

One specimen (FAS No. 4379) was collected by Colonel Robert

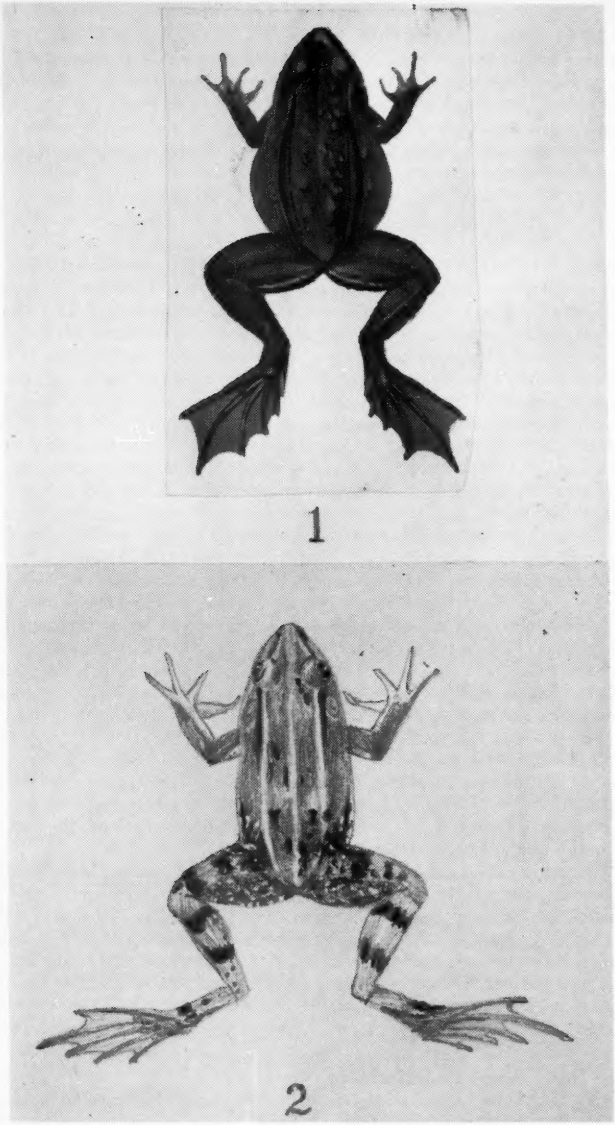

Plate I. Fig. 1. *Rana plancyi chosenica* Okada. Dorsal side ♂ X 1/3 (Drawing by Professor Cho after Okada, 1931.) Fig. 2. *Rana plancyi plancyi* Lataste. Dorsal side ♀ X 2/3. (Adapted from Okada, 1931.)

Traub, on May 9, 1952, at Yongdung'po. Other localities from which the frogs have been collected are Pusan, Kongju, Suigen, Seikan, Seoul, and the vicinity of Munsan-ni.

Rana amurensis coreana Okada new combination.

1926. *Rana temporaria coreana* Okada, Annot. Zool. Japan, v. 11, n. 42, p. 97.

1907. *Rana japonica* Stejneger, Bull. U. S. Nat. Mus., v. 58, p. 111 (part).

Rana amurensis coreana may be easily distinguished from *Rana temporaria dybowski* by the presence of nearly straight dorsolateral folds, by a more slender general body configuration and a smaller size, and, more specifically, by a lack of vocal sacs and ostia in the males. The species differs from Japanese specimens of *Rana japonica* in several ways. Specimens of *R. a. coreana* all have a pair of paravertebral dark stripes extending from the posterior portion of the head for the full length of the body. These stripes may be broken or undulent, but they are always identifiable as stripes. Dark markings may be present in specimens of *R. japonica,* but they are more like cryptograms and are never in the form of stripes. The toes of *coreana* are not as fully webbed as those of *japonica,* the distal two phalanges of the first, second, and fifth (distal 2½ of third toe and 3 of fourth) being free of web. An outer metatarsal tubercle was present and distinct in all of 40 specimens of *coreana* examined for such a character. The tubercle is only indifferently present in Japanese specimens of *japonica.*

Boulenger described *Rana amurensis* (1886: 4) from the Amur Province of southeast Russia. Boulenger's description included the facts that his new species had no vocal sacs and had short hind legs. No subspecies of *Rana temporaria* lacks vocal sacs in the male. In a forthcoming paper on the biogeographics of the woodfrogs, I shall further elaborate on the reasons for resurrecting Boulenger's *amurensis* and for delegating *coreana* as the southern subspecies of *amurensis.*

R. a. coreana replaces *R. t. dybowski* on the broad plains of southern Korea. The ranges of the two species are largely allopatric but with a fairly large area of overlap in central Korea. It may be noted that neither *R. a. amurensis* nor *R. a. coreana* are mountain populations, the former occurring in the low lands around Vladivostok.

Professor Cho states that large numbers of *R. a. coreana* may be taken on the campus of the University of Seoul following a rain. They are usually not far from water. One specimen (FAS No. 4526) was taken on the bank of a small creek 2 miles north of Ch'orwon; FAS Nos. 4527-28 from Yongdung-po; FAS Nos. 4529-45 from Seoul. The species has also been collected at Kongju, Hamhung, Inch'on, Suigen, and Seikan.

Rana temporaria dybowski Guenther.

1876. *Rana dybowski* Guenther, Ann. Mag. Nat. Hist., (4), 17, p. 387. Type locality: Abrek Bay, near Vladivostok. Type in British Museum.

1940. *Rana temporaria chensinensis* Pope and Boring, Peking Nat. Hist. Bull., v. 15, pt. 1, p. 57 (part).

1931. *Rana temporaria ornativentris* Okada, Tailless batrachians of the Japanese Empire, p. 111 (part). Werner's type locality is Yumoto, Nikko (Honshu Island, Japan).

A single large adult female (FAS No. 4525) bloated to the bursting point with eggs was taken at 9:00 P.M. from a rice paddy 8 miles south of Ch'orwon, on April 14, 1952. The frog was seen sitting half submerged in the shallow water in the middle of a chorus of *Rana nigromaculata*. The air temperature was 50° F. and the water temperature 54° F. Further diligent searching on that and subsequent nights failed to produce other individuals. The frog had an orange venter, grading into a more yellowish color posteriorly. The ventral surfaces of the legs were blood red.

Pope and Boring (1940: 51) feel that *R. amurensis* and *R. asiatica* are synonyms of *R. t. chensinensis*. Liu (1950: 279) thinks that *amurensis* is a valid subspecies of *temporaria* occurring in the three eastern provinces of China, "larger in size than other Chinese woodfrogs and with very narrow dorsolateral glandular folds." He states that "the capacity of the oviduct to absorb water is a remarkable specific character of this form." All the females in his collection and in the collection of Yenching University "have their abdomens fully expanded and in some cases the abdominal wall is ruptured near the pelvic region, where the jelly-like substance of the enlarged oviduct can be seen." Liu has not found this to be true of other closely related woodfrogs, although all were preserved in 5% formalin. The observation is true of the above listed female from near Ch'orwon. Other differences separating *chensinensis* from *dybowski* will be presented in a future paper, as will reasons for confining the name *ornativentris* to frogs from the mainland of Japan, where the population was described from Honshu.

Other localities for *R. t. dybowski* are: Pu-Ryong, Hoeryong, Musan Pass, Wonsan, Ch'ongjin, Seoul (doubtful), Rahoku, Komazan, Po'ha-dong.

Family Dermochelidae

Dermochelys coriacea schlegeli (Garman).

The turtle has been reported from near Mokp'o, Korea, by Hironobu Doi (1936: 109).

Family Cheloniidae

Chelonia mydas japonica (Thornberg).

This turtle has been reported from the ocean off Paek-a by Hironobu Doi (1936: 110).

Family Testudinidae

Geoclemys reevesi (Gray).

A single example was seen by Sergeant Harmon on the north bank of the Hantan-chon River, about 10 miles south of Ch'orwon. The turtle was plodding along a grassy bank and, upon being disturbed, partially withdrew into its shell. Other known Korean localities are Seoul, Inch'on, Ch'ongju, and Haeju.

Family Trionychidae

Amyda sinensis Wiegmann.

1925. *Amyda maackii* Slevin, Proc. Cal. Acad. Sci., v. 14 (5), p. 100.

Three of these turtles (FAS 4704 is the only one tagged) were collected from the Hantanchón River about 10 miles south of Ch'orwon

during May of 1952. They have also been collected from Kongju and from P'yongyang.

If the subspecies *maacki* is valid, the name should be applied to the population from the southern tributaries of the Amur River and from Korea. According to Pope (1935: 60), it is likely that the names *schlegeli, sinensis,* and *maacki* apply to nothing but ontogenetic stages of the same species, with *sinensis* being the senior synonym.

Family Gekkonidae

Gekko japonicus (Duméril and Bibron).

That this little species has at least a toe hold in Korea is indicated by Stejneger (1907: 166) who reports upon three specimens collected by Jouy from Pusan. Okada (1936: 251) states that Doi collected one specimen from Pusan but that he has never since collected the species in Korea. The lizards are frequently found in northern Honshu and on Tsushima Island.

The recording of *Hemidactylus frenatus* may be noted here. Stejneger (1907: 174) mentioned a specimen collected by a Sir E. Belchur from an unnamed locality in Korea. The record is mentioned again by Okada (1936: 267). The presence of the lizard in Korea is about as impressive as that of the notorious boa constrictor from Iowa.

Family Lacertidae

Takydromus amurensis Peters.

One specimen (FAS No. 4705) was collected by Sgt. McGowan, at the base of a hill 4 mi. SW Kumhwa, March 18, 1952. The terrain was rocky with scattered pine trees. The following CAS specimens collected by Dr. J. C. Thompson during May and June, 1911, were examined by the author: CAS 31685-31719, Wonsan; CAS 31824-31828, Pu-Ryong; CAS 31837-31839, Shoko; CAS 31812, Suigen. Other localities mentioned by Slevin (1925: 94) are Kongju, Musan Pass, Ch'ongjin, and Hoeryong.

Enlarged dorsal scales vary from 7 to 11 (usually 8), a central row or two of which may be somewhat reduced; ground-color olive brown; black dorsolateral stripe located just below keeled rows, bordered below by a white, thin band extending from snout to groin. The white border may be broken by black blotches, or may be reduced or absent. Occasional specimens are practically without pattern.

Takydromus auroralis Doi.

1929. *Takydromus auroralis* Doi, Korean Biol. Assoc., v. 9, pp. 1-3.

The species, recorded from the vicinity of Seoul, is characterized by three pairs of chinshields, six rows of enlarged dorsal scales, and three femoral pores on each side.

Takydromus kwangakuensis Doi.

1928. *Takydromus kwangakuensis* Doi, Chosen Iho, pp. 70-75.

The lizard is known only from the type locality of Mt. Kwanak, near Seoul. The presence of four femoral pores on each side combined with six rows of enlarged dorsal scales and absence of a lateral white line lend strong support to the probability that the population constitutes a valid species.

Takydromus tachydromoides (Schlegel).

This Japanese lizard is rather doubtfully included in the fauna of Korea on the basis of a report by Okada (1933: 145).

Takydromus wolteri Fischer.

1885. *Takydromus wolteri* Fischer, Jahrb. Wiss. Anst. Hamburg, v. 2, p. 82. Type locality: Chemulpo (Inch'on), Korea.

The lizard is reported in the literature from Pusan, Seoul, Suigen, Wonsan, and Inch'on. One specimen (FAS No. 4706) was collected by the author 8 mi S of Ch'orwon, May 5, 1952, on the grassy slopes of a hill with a scattered cover of pine. A number of specimens from the California Academy of Sciences were examined as follows: CAS 35945-35954, 31546-31864, Pusan; 31813-31817, 31807-11, Chikan (Suigen); 31734-31735, Wonsan. As reported by Slevin (1925: 94), all specimens have a single femoral pore on each side. A dark dorsal stripe is present, measuring about three scales wide; a distinct, white, ventro-lateral band one scale wide extends from tip of nose to groin.

Eremias argus Peters.

Twenty specimens are cataloged as follows: FAS No. 4695, 5 mi W Ch'orwon; FAS 4697, 4 mi S. Kumhwa; 4698, 4701-03, 8 mi S. Ch'orwon; 4699, 3 mi S Ch'orwon; 4700, 13 mi S Ch'orwon, and 4696, 19 mi S Ch'orwon, collected between March 30 and July 26, 1952. Nineteen of Prof. Cho's specimens from Seoul were examined at the University of Seoul.

Stejneger (1907: 248) has a good description of *E. argus* based upon a specimen from Seoul. A few individuals have the prefrontal azygous scale broken into one or two additional scales. Femoral pores are usually 10-10 or 11-11, but may vary from 9-13.

Other published records for the species are Konju, Suigen, and Inch'on.

Family Scincidae

Scincella reevesi (Gray).

Okada (1939: 202) rejects attempts to distinguish the oriental population, *Leiolopisma reevesi*, from the North American, *L. laterale*. He apparently does so, with considerable justification, on the basis that distinguishing characteristics are not constant. Schmidt (1927: 424) feels that the two populations should be specifically differentiated on the criteria that the prefrontals of *reevesi* are usually in broad contact, that the scales are in 30-33 rows (26 specimens) (less than 30 in *laterale*), and that *reevesi* has much more yellow in its coloration, the lateral dark bar being broken by light spots or vermiculations. Schmidt states that the scales around the body ranged from 26 to 30 in 28 specimens of *L. laterale*, with only one specimen having 30 rows. Smith (1946: 338) states that these rows vary from 26 to 32, usually 28 or 30.

Schmidt (1927: 425) describes the Tsushima population as *Leiolopisma vandenburghi* on the basis of having only 12 subdigital lamellae as compared to 16-19 in *reevesi*.

Korean specimens are recorded from Seoul. Professor Cho stated (letter) that the lizards are found on Mt. Diamond, near Seoul. No specimens are available for examination, so the relationship of the Korean population to that of *vandenburghi* on Tsushima remains problematical.

Eumeces coreensis Okada.

1937. *Eumeces coreensis* Doi and Komita, Zoological Mag., v. 49 (6), pp. 211-215, text figs. 1-4.

According to Okada (1939: 187), the species differs from *E. chinensis* and *"E. pekinensis"* (=*xanthi*) in the following characters: only one postmental, prefrontals in contact with each other, six upper and lower labials; *E. coreensis* differs from *E. c. chinensis* in having two upper labials in contact with posterior loreal and from *E. xanthi* in having no postnasal. Taylor (1935: 243) states that *E. xanthi* varies in that one specimen shows only six upper labials. According to his Fig. 33, the prefrontals are in contact. *E. xanthi* usually has 22 rows about the middle of the body, one in nine having 24. Both known specimens of *coreensis* have 24. Like *xanthi, coreensis* has four narrow, dark dorsal bands, but Okada states that these are situated on the four median dorsal rows whereas those of *E. xanthi* are located on the two median dorsal rows and on the third scale row. Both species have a broad, dark lateral band.

There is little reasonable doubt that the name *E. coreensis* is applied to a valid population, but the species is indubitably closely related to *xanthi* of northeastern China and western Manchuria.

Eumeces coreensis was described from a female and a male from Sampoto near Yongamp'o and one male from Sin-do Island, Korea. It is suggested that the type locality be restricted to Sampoto.

Family Colubridae

Natrix tigrina lateralis (Berthold).

Forty-two specimens were collected, 40 of which are reported upon as follows: FAS Nos. 4594-95, 4599-4606, 4611-12, 4615, 4618, 8 mi S Ch'orwon; 4597, 4 mi E Ch'orwon; 4598, 4607, 4609, 5 mi E Ch'orwon, 4593, 20 mi N Seoul; 4610, 4622, 4626, 4629, 4 mi E. Kapyong; 4624, 3 mi E Kapyong; 4596, 6 mi E Kapyong; 4621, 12 mi E Kapyong; 4613, 54 mi NNE Seoul; 4628, 55 mi NNE Seoul; 4623, 51 mi NE Seoul; 4608, Seoul; 4614, near Wonchon; 4620, 3 mi W Chunchon; 4616-17, 25 mi SE Kumhwa; 4639, 23 mi S Kumhwa; 4630, 20 mi SE Kumhwa; 4619, 18 mi S Kumhwa; 4625, 4627, 4638, 3.5 mi S Kumhwa.

The species was collected until October 23 of 1951 and was first taken in 1952 on May 3.

Ventral counts on the males averaged 160 (153-165); females, 165.2 (161-174); male caudals, 68.5 (62-74) female, 61.4 (55-72); male, % tail of total length, 21.7 (20.4-24.2), female, 18.6 (17.3-20.3). Cross bands on body varied from 41-56 with from 7 to 23 anterior interspaces containing some evidence of red coloration. No sexual dimorphism was apparent in the pattern.

A tendency for a clinal increase in ventral count in the southern China-Manchuria-Korea sector invalidates Stejneger's (1907: 278) conclusion that *N. t. tigrina* of Japan could be differentiated from *lateralis* on the basis of having a ventral plus caudal count of 227-248 (236.1) for *tigrina* and 206-224 (215.2) for *lateralis*. The Korean population samples vary from 220-238 and average 227.4. On this basis the Korean sample would perhaps appear to be closer to *tigrina* of Japan, but the caudal counts reveal the difference. Fifteen males from Japan vary from 68-83 and average 78. Twenty-three females vary from 66-80 and average 72. No significant variation in scale count is noted from north to south Korea.

The snakes were most frequently taken in the lower hills of the bivouac area or in the grass bordering the clear streams. They were only occasionally taken in the swampy ground of the rice paddies. None were observed in water.

One stomach yielded a large *Rana nigromaculata* which had been swallowed rear end first. Pope (1935: 138) records Chinese specimens as consuming tadpoles, frogs, and toads.

Other locality records for the species are Pusan, Kongju, Wonsan, Suigen, Uiju, 5.8 mi SW Inje, 3 mi SW Mundung-ni, 8 mi N Yanggu, and the vicinity of Munsan-ni.

Natrix vibakari ruthveni Van Denburgh.

1923. *Natrix vibakari ruthveni* Van Denburgh, Proc. Cal. Acad. Sci., ser. 4, v. 13 (2), p. 3. Type: CAS No. 31486, adult male. Type locality, Pusan.

Although no representatives of this subspecies were collected in Korea, the holotype was examined at the California Academy of Sciences.

The following counts of Korean specimens were gleaned from the literature: Ventrals of four males, 146-153; caudals of three males, 56-64; ventrals of four females, 142-150; caudals of four females, 58-65.

Van Denburgh (*op. cit.*) described the subspecies largely upon the basis of a lower caudal count of 55-65 compared with a caudal range of 62-83 in *N. v. vibakari* of Japan.

The population appears to be found from one end of Korea to the other. It is recorded from Quelpart Island, Pusan, Sinuiju, and Possiet Bay (on the Korean frontier) to Vladivostok and Khabarovka at the junction of the Ussuri.

Dinodon rufozonatum (Cantor).

Ten specimens were collected. Nine are reported as follows: FAS Nos. 4683, 4685-87, 4689, 21 mi S Kumhwa; 4688, 17 mi S Kumhwa; 4681, 5 mi S Kumhwa; 4682, 7 mi E Kapyong; 4684, 9 mi S Ch'orwon. The Ch'orwon individual was taken May 28, 1952, the rest from August until the end of October, 1951.

Five males had ventrals varying from 200-204; caudals, 64-78; % tail of total, 17.5-18.7. Four females had ventral counts of 197-209; caudals, 64-75; % tail of total, 14.4-18.1. A slight sexual dimorphism may exist, but it is difficult to define on the basis of such a small series. Dorsal bands varied from 61-75 on body and 17-24 on tail. The position of the loreal was quite variable, failing to enter the eye on one side of five specimens. In one instance the separating obstacle was the fourth supralabial and in the rest, the third; supralabials usually 8, frequently 7 on one side; infralabials 9-9, 10-10, or 9-10; scales in 17-17-15 rows. The largest specimen, a male, was 1077 mm. in total length, next in size being a 1053 mm. female. Both specimens are considerably longer than those reported by Pope (1935: 202).

These snakes were usually collected during the warmer part of the day on the lower slopes of the hills or in the swampy ground both adjacent to and part of the rice paddies. Captives were somewhat treacherous in habit, with inclinations toward running their heads over the restraining hand, then suddenly sinking their teeth into a tender portion.

A *Rana nigromaculata* was taken by a captive specimen. Pope (1935: 20) records Chinese specimens as consuming lizards, frogs, toads, fish, and even a guinea pig.

I have followed Pope (1935: 202), Maslin (1950: 442), and others in relegating other subspecies to *rufozonatum*.

Other localities from which *D. rufozonatum* has been secured are Seoul, Pusan, and the vicinity of Munsan-ni.

Zamenis spiralis (Peters).

Six of these snakes were collected. Five of them are recorded as follows: FAS No. 4690, 7 mi NE Seoul; 4691-4692, 4 mi E Kapyong; 4693, 23 mi S Kumhwa; 4694, 7 mi S Kumhwa. October 23 was the last date of collection for 1951, and April 1 the first for 1952.

From the literature and from the above collection, four males were found to have ventral counts varying from 185-191; caudals, 88-102 (86, 88, 88, 102); % tail of total length in two males, 25 and 27.1. Ten females had ventral counts of 194-205; caudal counts, 81-96; % tail of total length in six females, 24.6-27.1. Sexual dimorphism is apparent only in the ventral counts. The largest male was 745 mm. in total length, the largest female, 904.

Short transverse black bars are evident on the anterior dorsal scales bordering the vertebral stripe of one adult female. They are absent or poorly developed in the rest. Alternating dark and light lateral stripes are evident only on the posterior half of the body and on the tail.

Although Pope (1935: 226) mentions the food of Chinese individuals as being lizards, a mouse was found in the stomach of the 904 mm. female from 4 mi E Kapyong.

The snakes were all taken on hillsides or in high, dry valleys, where they would try to escape into grass or low shrubs upon being surprised. They had the alert reflexes expected of racers and moved with considerable speed. Their temperament was nasty, and they struck repeatedly upon being captured.

There are at least as many differences separating these snakes from *Coluber* and *Masticophis* as there are separating the latter two genera, and I do not feel that they should be combined with either.

The snake has been taken at the following additional localities: Suigen, near Munsan-ni, Inch'on, P'yongyang, and Hoeryong.

Elaphe dione (Pallas).

Five specimens were collected: FAS No. 4671, 3 mi S Ch'orwon; 4670, 6 mi S Ch'orwon; 4666, 18 mi S Ch'orwon; 4672, 18 mi S Kumhwa; 4669, 25 mi S Kumhwa. The last specimen collected in 1951 was taken on September 28 and the first in 1952 on May 2.

The following data (11 males and 10 females) were gleaned from the above specimens as well as from literature records: male ventrals, 181-204 (188.2), female ventrals, 193-205 (199.5); male caudals, 60-73 (69), female caudals, 56-71 (62.8); male % tail of total, 17.6-23.3 (20.5) and female % tail of total, 15.6-18.7 (17.6).

A complete description of a Korean specimen is provided by Stejneger (1907: 316).

Pope (1935: 243) records the food of Chinese individuals as birds and small mammals. Somewhat to my surprise, a captive Korean example ate a *Rana nigromaculata*.

All specimens were collected on roads or grassy hillsides. Stewart (1954: 66) found one of the snakes in a tangle of roots and rocks on the summit of a mountain.

Other recorded localities are Kongju, Seoul, Suigen, Pu-Ryong, Ch'ongjin, 6.4 mi ESE Mundung-ni, and vicinity of Munsan-ni.

Elaphe rufodorsata (Cantor).

Twenty-nine of these snakes were collected. Twenty-eight are recorded as follows: FAS No. 4657, 3.5 mi S Ch'orwon; 4640-43, 4647-49, 4652-53, 4655-56, 4663-64, 4668, 8 mi S Ch'orwon; 4650, 10 mi S Ch'orwon; 4646, 12 mi SE Ch'orwon; 4659, 18 mi S Ch'orwon; 4665, 21 mi SW Ch'orwon; 4654, 23 mi S Ch'orwon; 4644, 4658, 4660-61, 4 mi E Kapyong; 4662, 55 mi NNE Seoul; 4645, 10 mi S Kumhwa; 4667, 21 mi S Kumhwa; 4651, Yongdung-po. The species was collected until November 3 of 1951 and was first collected on April 30 of 1952. The snakes were commonly seen by early May.

The male ventral average was 167.5 (161-175), female ventral average, 177.4 (168-183); male caudal average 60.8 (57-67), female caudal average 50.9 (47-56); male % tail of total average 20 (18.8-20.7), female 16.5 (15.5-17.1). Strong sexual dimorphism is thus apparent.

The largest female in the series measured 785 mm. in total length, the longest male, 631 mm.

The lateral stripe is usually on the third and fourth scale rows anteriorly and on the third and fourth or second and third scale rows posteriorly; dorsolateral stripe usually on sixth and seventh scale rows.

A favorite habitat for the snakes was the rocky border of a large stream 4 mi E Kapyong. The water at this spot was four or five inches deep and grass was profuse. The snakes would prowl through the grass and shallow water in search of young *Rana nigromaculata* and could also be found in the rice paddies or at a considerable elevation on the lower hillsides of the bivouac area. A fish was taken from the stomach of one specimen. Stewart (1954: 67) found a *Bombina orientalis* in the stomach of one snake. The animal was apparently not deterred by the irritating secretion of the toad.

Other localities for the species are Seoul, 5.8 mi SW Inje, Pusan, Wonsan, Suigen, and Pu-Ryong. It has also been collected at Vladivostok, near the Korean border.

Elaphe schrencki anomala (Boulenger).

Eight of these snakes were collected: FAS No. 4673, 8 mi S Ch'orwon; 4674, 4 mi N Uijongbu; 4675, 7 mi ENE Seoul; 4676, 18 mi ENE Seoul; 4677, 50 mi NNE Seoul; 4678, 18 mi S Kumhwa; 4679-80, 23 mi S Kumhwa. None of these snakes was found in a damp habitat.

The last snake of 1951 was collected on September 22, and the first of 1952 on May 4. In the fall of 1951 these snakes were probably abroad until at least the middle of October.

The following records of 14 males and 8 females are from the literature and from the above collection: male ventrals varied from 212-227 (217), female, 218-230 (225.4); male caudals, 62-76 (70.7), female, 65-72 (68.1); male % tail of total, 16.3-20.3 (17.9), only one intact female available, 15%.

Pope (1935: 266) resurrects the name *anomala* for the population "from Shansi, Shantung, Hopei, Jehol and part of Korea." He records *E. s. schrencki* as a northeastern population "found in Manchuria and the region eastward to the sea." He has examined material from Seoul and believes it to be "perfectly typical" of *anomala*. He states that juvenile individuals of both subspecies are nearly identical, with a spotted venter, a postocular dark bar, and black-bordered dorsal blotches. Adult individuals of *anomala* have "a varying but usually very small remnant of the postocular stripe;" lose the dorsal blotches except for "the black edges of the dorsal bands which are, however, generally only evident posteriorly and even there quite weak and indistinct;" and have only "a faint trace of the ventral spotting (often entirely absent)."

FAS No. 4675, an adult female (1452 mm. in total length) from 7 mi NE Seoul may be considered a representative example of *anomala*. It has the dorsal blotches obscured almost absent; ventral markings absent, except on tail. FAS No. 4674, an adult male 1339 mm. in total length, from 4 mi N Uijongbu (about 22 mi directly north of Seoul) is fairly typical of *anomala* with obscure marbling extending the length of the venter. FAS No. 4673, a 1542 mm. male from 8 mi S Ch'orwon, has evident, although faint, dorsal blotches; no postocular stripe; and ventral markings evident except on tail. FAS No. 4676, a 1630 mm. male, has plainly marked dorsal blotches ("29 rich chocolate bands on body and 14 on tail"); obscurely but obviously marked venter; distinct postocular stripe. It may be noted that this locality is in the hills bordering the plains surrounding Korea. FAS No. 4677, a 1690 mm. male (largest specimen) has 19 blotches on body and 17 on tail; little trace of ventral mottling except on most anterior portion of belly; postocular stripe is distinct. FAS No. 4678, a 1476 mm. female, has 35 obscure dorsal blotches; ventral marbling faint but evident for length of venter; postocular band evident but indistinct.

The above specimens are apparently intergrades with the exception of the two from Uijongbu and from near Seoul which should be allocated to *anomala*.

California Academy of Sciences specimens from Suigen (Chiksan) and Pusan lack bands and ventral spotting. The postocular bar is present although in CAS No. 31519 (from Suigen) it is faded. The Wonsan specimen (CAS No. 31497) is strongly banded with a prominent postocular bar and ventral spotting and is thus typical of *E. s. schrencki*.

While interpretation of the Korean range of *anomala* may be open to question, it seems likely that the population is restricted to the coastal areas of P'yongan Pukto, P'yongan Namdo, the western half of Hwanghae Do, the coastal area of Kyonggi-Do, then expanding its range to cover the whole of South Korea exclusive of Kangwon Do. The range of *E. s. schrencki* would then be represented by the mountainous areas of northern and eastern Korea with gene exchange to the west and south.

Elaphe schrencki schrencki Strauch.

CAS No. 31497 from Wonsan.

Possible intergrades are reported under the discussion of *E. s. anomala*. *Elaphe taeniurus* Cope.

The only record for Korea is one of indeterminate locality collected

by Dr. N. M. Ferebee, illustrated and described in some detail by Stejneger (1907: 320). According to Pope (1935: 274) the only records for Asia northeast of Peiping are the Korean record, one for Possiet Bay, and one for the Yalu River Valley. Pope feels that *taeniurus* was carried into northern China by man.

Family Hydrophiidae

Hydrophis melanocephalus Gray.

The only known Korean locality is Choryong-do (Cho, correspondence).

Pelamis platurus (Linneaus).

The species is recorded from Possiet Bay (near the Korean border) by Maki (1931: 194). Professor Cho (correspondence) states that these snakes have been taken from the Korean coast town of Choryong-do.

Family Crotalidae

Ancistrodon halys brevicaudus Stejneger.

1907. *Agkistrodon blomhofii brevicaudus* Stejneger, Bull. U. S. N. M., No. 58, p. 463. Type locality: Pusan.

Seven specimens of this little pit viper are reported as follows: FAS No. 4632, 54 mi NE Seoul; 4633, 40 mi NE Seoul; 4634, 23 mi S. Kumhwa; 4635, 4 mi E Kapyong; 4637, Kapyong; 4636, 8 mi S Ch'orwon. They were collected from August through October of 1951 and in June of 1952. Five additional specimens from Suigen, Wonsan, and Pu-Ryong were examined from the California Academy of Sciences collection, and data on nine more from the vicinity of Munsan-Ni were kindly furnished by Mr. James Dixon.

These diurnal snakes prefer the low, marshy environment provided by rice paddies or meandering streams. They may at times be found on the lower slopes of the hills but seldom penetrate to any considerable altitude. Koba (1938: 247) states that individuals from Syoryuzan Island, Kwangtung, and South Manchuria subsist largely on birds; Pope (1935: 394) lists mice, rats, lizards, and a frog (*Rana nigromaculata*) from the stomachs of Korean specimens. The snakes are usually mild in disposition, seeking to escape even when annoyed. Many Koreans have an exaggerated fear of them but collect them for sale for medicinal use.

The use of subspecific names for *Ancistrodon halys* has led to little but confusion. Thompson (1916: chart) summarized the data on ventrals and caudals of the different subspecies and came to the conclusion that they could not be differentiated on that basis, and certainly not upon the basis of color. His chart might have been more useful had he separated the sexes. Pope (1935: 396) has followed Thompson since "ventral, subcaudal, upper labial and scale row counts intermediate between those of central Asia and those of the Yangtze Valley" are present. Stejneger's (*loc. cit.*) color differences of his type description of *brevicaudus* do not appear to be valid. A computation of the standard error for ventral and caudal counts of 39 specimens from Korea and 39 from Japan shows a highly significant *t* value for the two populations, thus the decision to retain the name *brevicaudus* for the Korean population. The sexes are lumped, as in most cases they were unknown. The fact does not, of course

enhance the value of the data. No attempt is made to justify subspecific names for other populations. Other localities from which the snakes have been collected are: Wonsan, Suigen, Pu-Ryong, Shoko, Musan Pass, Munsan-ni, Seoul, Keijo, Hoeryong, Kowan, Haeju, Puksubaek-san, Kaesong, and Sinuiju.

	Korea	*Japan*	*t*	*P*
Ventrals	147.0 ± 0.60 (139-154)	140.3 ± 0.52 (132-146)	8.5/	.001
Caudals	41.5 ± 0.76 (31-52)	48.2 ± 0.82 (32-58)	6.0/	.001

Family Viperidae

Vipera berus sachalinensis Carewskij.

Reports of the species from northern Korea by Maki (1931: 196) are confirmed by Professor Cho (letter) who states that the snakes have been collected at Sinuiju.

The Korean specimen described by Maki has a total length of 635 mm.; tail length, 67 mm.; ventrals, 156, and caudals, 34. The sex is unknown.

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WICKENBURG, ARIZONA

A Collection of Amphibians and Reptiles From West Central Korea

By JAMES R. DIXON

During the spring and summer of 1952 the author collected a group of amphibians and reptiles from the Munsan-chón River Valley of west-central Korea while serving with the United States Marine Corps, First Marine Division.

One hundred and twenty-seven amphibians of 6 species, 75 lizards of 3 species, and 42 snakes of 7 species were collected over a five-month period. The collecting area consisted of several unnamed tributaries flowing into the Munsan-chón River near the village of P′aiu-ri (fig. 1). This area is approximately 30 miles NNE of the capital city of Seoul. The surrounding hillsides were covered with a variety of grasses, legumes, pines, and junipers. The valley floor consisted of a few bare sandy areas and flatlands with the dominant vegetation a variety of grasses. There were scattered stands of deciduous trees along the larger tributaries, but the dominant tree growth was a pine-juniper association. The entire collecting area covered approximately 9 square miles.

Bufo bufo gargarizans (Cantor)

Two adult males were collected ¼ mi. N P′aiu-ri, 250 ft., July 4 and 26, 1952, during a heavy rain. Their respective measurements are in mm.: snout-vent 64, 60; head width 25, 22; head length 20, 17; greatest diameter of eye 7, 6; diameter of tympanum 4, 3.5; foot length 29, 28; and tibial length 25, 22. The foot is three-fourths webbed; tympanum small but distinct; cranial crests absent; series of 4 enlarged parallel tubercles at posterior corner of jaw; dorsum and extremities with many large tubercles tipped with olive-brown; grayish black bar from eye to lip; black band from eye to arm insertion, fading out on sublateral surface; ground color grayish black; limbs barred with dull yellow on ground color; dorsum generally olive-brown and black on ground color.

These toads were not common in the area and appeared to come out only after heavy rains. The voice was not heard. Unlike our American species, this toad does not often "hop." The author attempted several methods to test its ability to "hop" but on all occasions both specimens placed one foot in front of the other and "walked" away. These toads appear normally to have a slow creeping gait and they are not as discernible at night as our American "hopping" variety.

Hyla arborea japonica Guenther

Thirty-one young, 9 adult males, and 1 adult female were collected 1½ mi. E P′aiu-ri, 250 ft., between April 30 and July 9, 1952. Measurements in mm., maximum snout-vent, foot, and tibia of males, respectively, 33, 16, 14; minimum in males, 27, 13, 12; single female, 37, 17, 16. Ground color bright green; dark brown bar from eye to lip; dark brown band from snout to groin; occasionally a few dusky spots on dorsum; lower lips mottled dusky and white; belly whitish.

All specimens were captured during daylight. They were more frequently found in the streams on aquatic vegetation but were occasionally collected in shrubs along the bank.

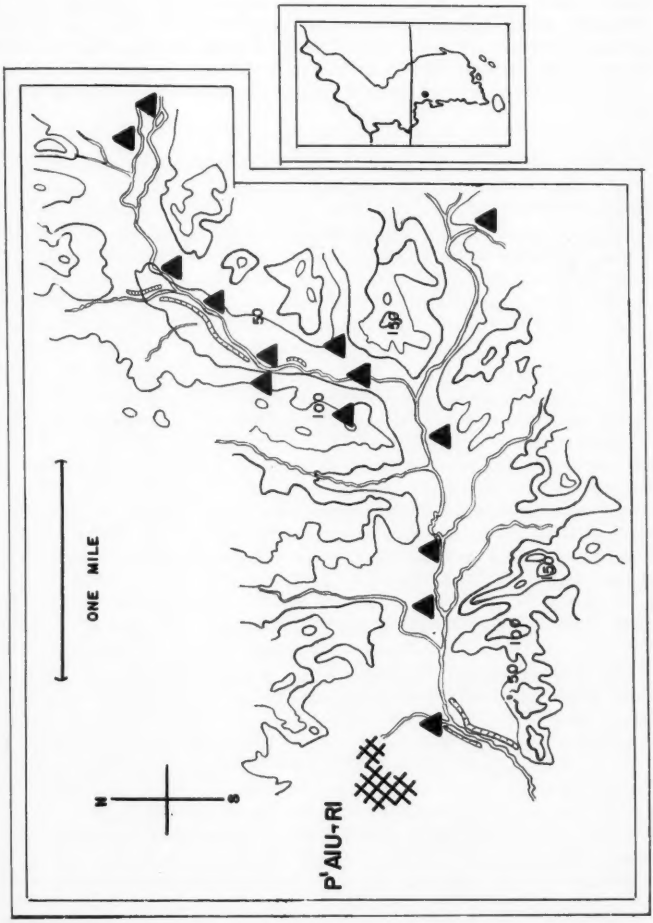

Fig. 1. Collecting stations located along the streams flowing into the Mimsan-chón River, near the village of P'aiu-ri. (elevation in meters).

Rana nigromaculata Hallowell

Fourteen adult males and 4 adult females were collected ¼-3 mi. E P' aiu-ri, 250 ft., between April 1 and May 31, 1952. All were captured in streams or rice paddies. Measurements in mm., maximum snout-vent, foot, and tibia of males, 68, 42, 34; minimum in males, 53, 32, 26; maximum of females, 76 44, 38; minimum of females, 53, 30, 26. A narrow dorsolateral fold from eye to groin; four irregular longitudinal dorsal folds; skin distinctly shagreen. Ground color tan to brownish olive; pattern of elongate brownish black spots on dorsum and side; median yellowish white line from snout to anus; dusky to dark brown cross bars on femur; belly yellowish white to pale white.

Six breeding individuals were collected in a rice paddy on April 14, 1952.

Rana plancyi chosenica Okada

One adult female was collected ¼ mi. S P' aiu-ri, 250 ft., May 21, 1952. This individual was captured in aquatic vegetation. Snout-vent length, 65mm.; foot, 34mm.; tibia, 27mm. A broad dorsolateral fold from eye to groin; skin faintly pustular. Ground color tawny to yellowish brown, with indistinct dusky spots on dorsum; femur faintly mottled with dusky or tannish brown.

This species appears to be quite rare in this area. There were no others seen or heard.

Rana amurensis coreana Okada

Twelve adult males and 6 adult females were collected 1½ mi. E P' aiu-ri, 250 ft., between April 30 and July 9, 1952. Most of the specimens were captured in shallow stream beds. Measurements in mm., maximum snout-vent, foot, and tibia of males, 41, 22, 20; minimum in males, 35, 22, 18; maximum of females, 45, 25, 22; minimum of females, 37, 22, 19. Snout pointed; a narrow dorsolateral fold from eye to groin; skin indistinctly shagreen; few small tubercles on dorsum. Ground color tan to clay; dorsum with few dusky spots; blackish brown line from nostril to arm insertion; femur indistinctly barred; belly yellowish orange to reddish orange.

There seems to be a remarkable similarity in appearance between these specimens and the American species *Rana sylvatica.*

Rana rugosa Schlegel

Thirty-four young, 1 adult male, and 7 adult females were collected 1 mi. E P' aiu-ri, 250 ft., between April 29 and July 9, 1952. All were taken from an aquatic habitat. Measurements in mm., maximum snout-vent, foot, and tibia of females, 54, 27, 26; minimum in females 42, 25, 24; of the single male, 54, 31, 30. Dorsolateral fold absent; skin densely granular; numerous short longitudinal ridges and large tubercles on dorsum and side; throat, groin, and underside of femur coarsely granular; vocal sacs absent. Ground color dark olive to brownish olive; femur indistinctly barred; posterior part of belly, femur, and heel ochre or reddish orange; large olive spots on belly (one without spots); throat and pectoral region yellowish to light olive.

All of the adult females were gravid. Most of the larger individuals were captured by feeling under the edges of undercut banks where small holes and pockets had been formed.

Takydromus amurensis Peters

One adult male was collected 1 mi. E P′ aiu-ri, 450 ft., on April 24, 1952. This lizard was captured on a steep rocky hillside in a pine-juniper association. There are 8 enlarged rows of dorsal scales anteriorly, the median two rows slightly smaller than the outer rows. The 8 rows are reduced to 7 from mid-body to the tail, with the median row subequal to the outer rows. The enlarged dorsal scales are strongly keeled to the tip of the tail. Femoral pores 3-3; supralabials 7-9; infralabials 6-6; submentals 4 pairs; snout-vent length 51mm. Ground color chocolate brown; bluish gray mid-dorsal stripe 6 scale rows wide; white line from eye through ear to arm insertion; chin immaculate; throat and pectoral region pinkish; belly reddish orange; ventral surface of limbs pinkish white.

This lizard appears to have an extremely long tail (159mm. in this specimen). Its movements resemble those of our American *Eumeces.*

Takydromus wolteri Fischer

Four adult males and 4 adult females were collected 1 mi. E P′ aiu-ri, 250 ft., between May 4 and May 28, 1952. All were taken in sparse grassy areas along streams. Dorsum with 8 rows of enlarged keeled scales, two median rows subequal to outer rows; femoral pores 1-1; infralabials 6-6 (in one 7-7); supralabials 6-6; submentals 4 pairs; maximum snout-vent of males, 50mm.; minimum, 46mm.; maximum snout-vent length of females, 52; minimum, 43. Ground color chocolate brown; broad light brown mid-dorsal stripe; lateral surface ground color; yellowish lateral line from nasal to rear limb insertion; chin, throat, and belly pinkish orange.

Three females contained well developed eggs. One individual was regurgitated by an *Elaphe rufodorsata.*

Takydromus sp.

One adult, gravid female was collected 1 mi. E P′aiu-ri, 250 ft., May 14, 1952, along the bank of a stream in a sparse grass flatland. Dorsum with 7 rows of enlarged keeled scales, median row subequal to outer rows; femoral pores 4-4; infralabials 6-6; supralabials 7-7; submentals 4 pairs; snout-vent length 47mm., tail length 98mm. Ground color chocolate brown; broad grayish blue mid-dorsal stripe; chin and throat pinkish orange; belly bluish gray.

This specimen differs from *T. wolteri* and *T. amurensis* by having the femoral pore count, 4-4; no lateral stripes, and the belly bluish gray. It more closely resembles *T. amurensis* in the high femoral count, and in having 7 rows of mid-dorsal scales. *T. kwangakuensis* has similar pore counts but different enlarged dorsals.

Eremias argus Peters

Thirty-four adult males and 29 adult females were collected ¼ mi. S P′ aiu-ri, 250 ft., between March 24 and June 1, 1952. All were captured in semi-bare sandy areas in the flatlands. Dorsal scales granular; belly scales large, subequal, in 12 rows across belly; submentals 6 pairs; infralabials 6-6; supralabials 8-8; femoral pores usually 11-11 but ranging from 8-9 to 12-12; maximum and minimum measurements in mm., snout-vent length of males, 57mm., 45mm., of females, 64, 44, of tail in males, 76, 44, of females, 70, 51. Ground color tan or light brown; 10 rows of

yellowish spots surrounded by black or dark brown rings on dorsal and lateral surfaces; 2 broken light yellow parallel lines from eye and supralabials to arm insertion. Venter pale white to yellowish; lateral surface of males rusty brown, females pale white; gular region in some males yellowish orange.

These lizards resemble the American *Holbrookia* in body form and speed. Their method of escape is also similar. They dash under nearby rocks or into clumps of grass for protection. Most of the females were gravid. One individual was removed from 4 inches below the frozen surface of the ground on March 24, 1952. At this time only the upper 2 inches of the ground were frozen.

Natrix tigrina lateralis (Berthold)

Two adult males, 1 young male, and 3 adult females were collected ¾ mi. E. P'aiu-ri, 250 ft.-450 ft., between May 4 and June 5, 1952. One individual was in a rock wall near a stream, 4 on the bank of a stream, and one high on a rocky hillside in a pine-juniper association. Scale rows 21-19-17; preoculars 2-2; postoculars 3-3 (in one 3-4); infralabials 7-7; supralabials 8/8 - 10/10; supralabials entering eye 3 & 4; temporals 1+2; maximum number of ventrals and caudals in males, 165, 66; minimum, 158, 65; maximum total length, 813mm.; minimum, 349mm. Maximum number of ventrals and caudals in females, 169, 62; minimum, 162, 53; maximum total length, 894; minimum, 800. Ground color jade green; alternating rows of square olive-green and black spots on dorsum; black pair of subcrescentic spots on neck, bordered above by a pair of large pinkish red spots; first 2 scale rows edged with light pink; lips dull yellow; chin and throat yellowish green grading posteriorly into greenish black or black.

The individual taken from the rock wall appeared to be in hibernation. A den was discovered in the wall by accident. The author was pursuing an *Ancistrodon h. brevicaudus* along the wall when it disappeared into a crevice. Upon removing several of the rocks a small hole was discovered which extended two feet into the soil back of the wall. This cavity contained 3 *Ancistrodon h. brevicaudus,* 1 *Natrix t. lateralis,* and 1 *Dinodon rufozonatum.* None of these was active.

Elaphe rufodorsata (Cantor)

Four adult males and 10 adult females were collected 1 mi. E P'aiu-ri, 250 ft., between April 30 and June 20, 1952. All but one of the females were gravid and it appeared to be a subadult. Scale rows 21-21-17; preoculars 1-1; postoculars 2-2; infralabials usually 10-10 but varying from 9-9 to 11-11; supralabials 7-7 to 8-8; supralabials entering eye 3+4; temporals 2+3; anal divided; maximum length of males, 584mm.; minimum, 533mm.; maximum number of ventrals and caudals, 171, 66; minimum, 165, 62. Maximum length of females, 775; minimum, 616; maximum number of ventrals and caudals, 187, 54; minimum, 174, 48. Ground color metallic grayish brown, each scale with black stipples; transverse black bar across prefrontals; metallic brown U-shaped band bordered by thin band of black from frontal across parietals and dorsally along each side of neck; dorsum with approximately 35 parallel rows of metallic brown spots fading into longitudinal stripes posteriorly; lips ochre or orange; diagonal black line from eye to side of neck; belly mot-

tled orange and black; caudals yellowish orange edged in black; chin and throat mottled orange and brownish black.

This species seems to be semi-aquatic because all individuals were captured in or near water. Stomach contents of these specimens consisted of *Rana rugosa, Rana amurenis coreana, Hyla a. japonica,* and *Takydromus wolteri.* Individuals collected on the banks of streams attempted to escape by entering the water and hiding in the aquatic vegetation. Nearly all attempted to bite when captured.

Elaphe schrencki anomala (Boulenger)

A single young female was collected 1 mi. E P'aiu-ri, 250 ft., May 4, 1952, in aquatic vegetation on the edge of a tributary. Scale rows 27-23-19; preoculars 1-1; postoculars 2-2; infralabials 10-11; supralabials 7-7; supralabials entering eye 3 & 4; temporals 2+3; ventrals 217; caudals 75; total length 419mm.; tail length 70mm.; anal divided. Ground color pale grayish brown; scattered elongate black spots on dorsum with two pale gray elongate spots bordered by black, on each side of nape; whitish stripe on first row of scales; labials pale gray, edged in black; transverse dark gray band across prefrontals through eye to last supralabial; rostral with inverted U-shaped black line on outer edge; belly pale gray anteriorly, shading into light pink posteriorly with each ventral edged in black.

Juveniles of this species are strikingly different in color from the adults. Old adults are nearly a uniform pale isabella color. It appears that this species is also semi-aquatic.

Elaphe dione (Pallas)

Three adult males, 1 young male, and 4 adult females were collected ½-1 mi. E. P'aiu-ri, 250 ft., between April 15 and July 13, 1952. One specimen was in the water of a stream, 3 on the bank of a stream, and 4 in upland areas. Scale rows 24-25-19; preoculars 2-2; postoculars 2-2; infralabials 11-11; supralabials 8-8; supralabials entering eye 4 & 5; temporals 2+3; anal divided. Maximum number of ventrals and caudals in males, 189, 76; minimum, 183, 67; maximum total length, 930mm.; minimum, 406mm.; maximum number of ventrals and caudals of females, 207, 64; minimum, 199, 62; maximum total length, 1003mm.; minimum, 622mm. Ground color reddish brown; numerous narrow irregular cross bars of dark reddish brown on dorsum, interrupted mid-dorsally and on the first scale rows by 3 light brown longitudinal stripes; reddish brown band crossing prefrontals through eye and fading into ground color posteriorly; a similar V-shaped band beginning on frontal and diverging posteriorly on each side of nape.

Stomach contents were not analyzed in this species but at the time of capture two individuals disgorged freshly captured food. One regurgitated a lizard, *Takydromus wolteri,* the other a small mouse. All captured specimens were docile and made no attempt to bite.

Zamenis spinalis (Peters)

One adult male, one young male, and one adult female were collected ¾ mi. E P'aiu-ri, 400 ft., between April 24 and July 3, 1952, on hillsides in rocky areas of the pine-juniper association. Scale rows 17-17-15; preoculars 2-2; postoculars 2-2; infralabials 9-9 (in one 11-11); supralabials 8-8; supralabials entering eye 3, 4, & 5; temporals 2+2 (in one

2+3); anal divided. Maximum number of ventrals and caudals in males, 188, 98; minimum, 186, 95; maximum total length, 713mm.; minimum, 432mm. Ventrals and caudals of the female, 204, 89; total length, 813mm. Ground color tan or light brown; 3 white longitudinal stripes on body, the mid-dorsal stripe from frontal to tip of tail; lips and chin immaculate; ocular scales white, edged with reddish brown; supralabials edged with dark reddish brown; venter ochre or brownish orange; outer edge of each ventral with a black spot.

In appearance these snakes resemble the American *Coluber* and move on the ground in similar fashion. This species is rare in collections but seems to be common in this area of Korea.

Dinodon rufozonatum (Cantor)

One adult female was taken ¾ mi. E P'aiu-ri, 250 ft., May 27, 1952, from a den in which it seemed to be hibernating. Scale rows 23-17-15; preoculars 1-2; postoculars 2-2; infralabials 10-11; supralabials 8-8; supralabials entering eye 3, 4, & 5; temporals 2+3; ventrals 200; caudals 58; anal entire; total length 876mm. Ground color coral red; alternating brownish black to black spots on dorsum and sides, separated by narrow bands of ground color; venter mottled with coral red and black, fading to black posteriorly.

After being handled for some time this individual exhibited a defense reaction much like that of the American genera *Abastor* and *Farancia*. When handled about the mid-body, the snake coiled its tail about the arm of the handler and harmlessly pressed the spine at the tip of the tail into his arm.

Ancistrodon halys brevicaudus Stejneger

Two adult males and 7 adult females were collected ¾-2 mi. E P'aiu-ri, 250 ft., between May 4 and June 25, 1952. Three of the snakes taken from a den seemed to be in hibernation. The others were collected in or near streams. Scale rows 25-21-17; preoculars 2-2 or 3-3; postoculars 2-2 or 3-3; infralabials usually 10-10 but varying from 9-10 to 11-11; supralabials 7-7; only third supralabial entering eye; temporals 2+3 or 2+4; anal entire. Maximum number of ventrals and caudals of males, 148, 47; minimum, 143, 43; maximum total length, 486mm.; minimum, 326mm.; maximum number of ventrals and caudals of females, 152, 45; minimum, 144, 42; maximum total length, 527mm.; minimum, 457mm. Ground color grayish brown to reddish brown; cross bands dark grayish brown to brownish black with outer edges grayish white (these bands extend to first scale rows); head light brown to reddish brown; venter mottled and grayish black, in some nearly all black; tip of tail yellowish.

Most of the individuals were pugnacious when first captured. All of the females were gravid.

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Aspects of the Thermal Ecology of the Yosemite Toad

By DON P. MULLALLY and JOHN D. CUNNINGHAM

The Yosemite toad (*Bufo canorus* Camp) lives chiefly within the Upper Canadian and Hudsonian Life Zones in the central Sierra Nevada Mountains of California. Less commonly the species is also found in the Middle Canadian and Arctic Alpine Life Zones. The writers have taken several summer trips into these parts of the Sierras during the last several years and have accumulated the data herein presented. Since the work was not sufficiently organized or continuous over an extended period of time, the results are only introductory. It is hoped, however, that they will lead toward a better understanding of the thermal relations of *Bufo canorus* and high altitude forms in general.*

Adaptation to environmental temperatures is equally as important as any other modification for the survival of a species. In one or several ways animals must be able to function under available temperatures. Behavioral mechanisms are of critical importance to all animals in this respect. Likewise, not only the endothermic mammals and birds, but also many ectotherms partially rely upon physical structures such as color, size, and insulation to prevent undue heat loss or gain. However, only the ectotherms must have physiological adjustments which enable them to endure and be active over a wide range of environmentally-induced body temperature. The nature of these adjustments is of great interest. While rather extensive work has been done on the thermal ecology, with special emphasis on the embryonic stages, of certain eastern species of anurans (see Moore, 1949; Volpe, 1953, and others of their publications), relatively little work has been done upon the amphibians of Western North America to determine the nature of their thermal adjustments. The present study is mainly concerned with the adults.

High elevations provide exceptionally rigorous temperature conditions to which the animals must adjust. They must escape freezing and be able to endure long periods of dormancy at near freezing levels. On the other hand, ectotherms must obtain sufficient heat to feed normally, reproduce and escape enemies. Many problems, such as those to be discussed, revolve around the question of body temperatures required for various activities, the warmth of the environment required before these body temperatures can be obtained and the parts of the environment from which the requisite heat or the unfavorable temperatures are derived. Thus the problems largely become physiological and microclimatic.

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METHODS

All but a few temperatures exceeding 50° C. and lower than 0° C. were secured with a small mercury Schultheis thermometer. Body temperatures were obtained by deep cloacal insertion. Substrate surface temperatures were secured by horizontally inserting the thermometer just deeply enough under the surface material to cover the bulb with the thinnest film. Air temperatures were taken at a height of ½ to 1 inch above the substrate upon which the toad was first noted. The thermometer was allowed to stabilize at the stated height in the investigator's shadow. Care was always taken to obtain temperatures not unduly influenced by radiation and conduction to or from the human body. Body temperatures were considered valid if obtained from animals which had been captured quickly and the temperatures secured immediately. If, while being pursued, the toads crossed terrain radically different from that upon which they were originally found, the resultant data were discarded. All environmental temperatures, except the ones on dry, hot soil and at a height of 5 ft., were taken within several inches of the positions where the animals were first seen. Since few toads were found upon dry soil with temperatures over 40° C., these readings were necessarily secured several feet from the toads. Because Schultheis thermometers register only to 50° C., higher temperatures are indicated in Figure 1 by solid triangles, except where additional instruments were used.

DIURNAL ACTIVITY

Mullally (1953) has noted the Yosemite toad to be strictly diurnal. This habit has subsequently been noted many times. Possibly exceptions occur during the breeding season when the reproductive stimulus may hold animals active after sunset. This situation would be analogous to the diurnal breeding of normally nocturnal *Bufo boreas halophilus* Baird and Girard (Mullally, MS), a very close relative of the Yosemite toad. During summer and fall, toads within long shadows in the late afternoon usually retreat down burrows. A few have been noted not to retreat immediately under such conditions, but to sit quiescently for 30-60 minutes a few inches outside their burrows. During mid-day though, it is common for the animals to be active within large patches of shade created by trees, ridges, and masses of rocks. Apparently the critical light relations involve more than mere presence of sunlight and shade. Either the angle of the sun or amount of reflected or incident light are more important in governing activity.

The diurnal habit enables the Yosemite toad to be active for a much longer part of the year than would be possible with a nocturnal one. Through May and into early June, at the elevations where this animal occurs, subfreezing temperatures usually commence in the afternoon or shortly after sunset, and deep snow usually persists in most sections. However, even in late April and May the days are usually warm and solar insolation intense. Thus it is undoubtedly the diurnal habit which permits April and May emergence from cold torpor and activity protracted into October (Stebbins, 1951).

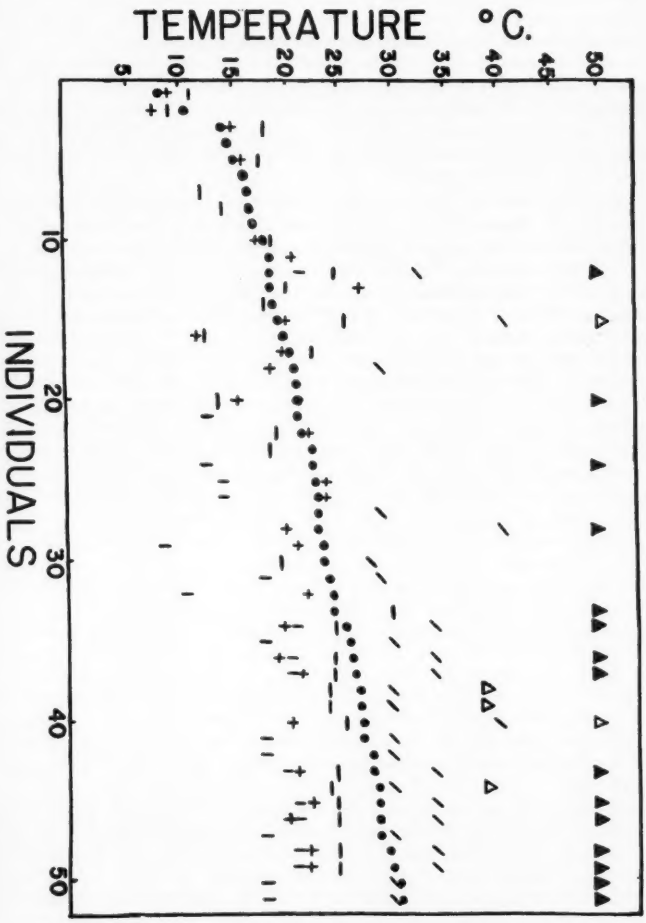

Fig. 1. Body temperatures and thermal environment of active *Bufo canorus*. Solid circles, cloacal temperatures; horizontal line, air at a height of ½-1 inch; vertical line, air at a height of 5 feet; plus sign, moist soil in shade or partial shade; oblique line, moist soil in sun; triangle, dry soil in the sun (a solid triangle indicates a temperature in excess of 50° C.). See text for a discussion.

MORNING EMERGENCE

During the summer and early fall, temperatures are normally sufficiently high at the time of long afternoon shadows and sunset to permit continued toad activity. However, early in the morning under similar lighting conditions, nearly the lowest temperatures of the environment prevail. Presumably the cold often delays emergence from subterranean retreats far into the day. It is probable that during the colder days of the activity season, Yosemite toads are active only after the morning's heating or in the afternoon. If the afternoon cools quickly, only a few hours of activity would be possible. A very restricted period of evening activity due to low temperature has already been noted for *Bufo boreas halophilus* (Mullally, 1952).

On September 8, 1953, Yosemite toads were found in String Meadow (9800 feet), Fresno County. Many were observed to spend nights within short, shallow burrows running under logs and rocks. The burrows may have been constructed by the toads or been modified rodent diggings. Most of the toads inhabiting these very shallow retreats were smaller than average. Perhaps population pressure was such that these climatically unfavorable retreats were the only ones available. At the end of each burrow was an enlarged depression holding one or more toads and an occasional *Hyla regilla* Baird and Girard. At sunup after cold nights which caused the moist soil surface to freeze, toads were excavated, and some were noted to have ice crystals on their backs. No body temperatures were secured. However, it was noted that several animals were a few inches farther forward from the depressions towards the entrances to their burrows than they had been the previous night. Apparently they had started to move towards the light cast by the slanting rays of the morning sun, towards which their burrows generally faced. For the following reasons such behavior is plausible: Soil, especially moist soil, is a very poor conductor of heat. Most of the day would be required to warm even the upper few inches of soil to a moderate temperature, and the deeper layers would scarcely be altered. Only by essentially disregarding the cold soil and emerging either in response to the light of the rising sun or an internal rhythm can toads obtain quantities of heat or emerge as early as they do. Of course, the soil must at least be warm enough to permit coordinated, effective movement. It is again pertinent to add that the close relative, *Bufo boreas halophilus,* is voluntarily active in nature with a body temperature of 2.5-3° C. (Mullally, 1952, MS).

Thermal data on emergence were collected on August 29, 1955, at an elevation of 9450 ft. at Elizabeth Lake in Yosemite National Park. By sunrise the temperature was several degrees below freezing, resulting in frost and a frozen ground surface in the meadow. At 9:15 A.M. a toad was noted in front of its burrow on the margin of the lake. While sun bathed the general area, its position had been continuously in shade. Mantling trees had kept temperatures there higher than in the meadow and had prevented freezing of the soil. The temperature of the animal was 8.2° C., of the soil 2 inches down the burrow 8.8° C., and of the air at a height of 1 inch 11° C. This is the lowest body temperature we have obtained for an emerging toad. Some animals have been found swimming in a creek of 7° C. Obviously, minimum temperature relations

have barely been investigated. It is almost certain that the species is active at much lower body temperatures than herein noted, especially during the spring emergence and breeding period.

When environmental temperatures are low, Yosemite toads seem to bask in the sun. At least they will sit in sunny positions for many minutes without moving. This behavior has been noted especially during early morning, late afternoon, and cool weather. At such times, the sun and soil are not overly or rapidly heating the toads. Basking toads usually have body temperatures below about 18° C. Favorite positions for basking are the entrances to burrows, ledges on banks overlooking water and sunlit places among low vegetation bordering upon water. Basking animals are usually quiescent and may easily be grasped before they move.

It has frequently been noted that a great many very immature tadpoles continue to exist within favorable waters up to at least mid-September. The same is true for the Sierra yellow-legged frogs (*Rana boylei sierrae* Camp), another anuran within the range of the Yosemite toad. The tadpoles of the frog are known to winter over and require two seasons of growth before metamorphosing (Stebbins, 1951). It then seems likely that the Yosemite toad also requires two seasons to metamorphose. A lengthened period of growth and maturation is not surprising considering the effect upon metabolism of the prolonged cooling of waters by melting snows and the short summers.

Since more than one season is seemingly required for the tadpoles to reach maturity, winters must be endured and unusually low temperature adaptations and tolerances are to be expected. Even in the summer, water temperatures may be low: On August 27-29, 1954, large tadpoles were noted in a small pond on the crest of Pine Creek Pass at an elevation of 11,170 feet. At this time, daily minimum temperatures were about 5° C. and ice formed overnight along shores, on quiet pools and around surfacing rocks. At mid-day the tadpoles were noted swimming in what appeared to be normal fashion within waters of 8-10.6° C. These were the coldest daytime waters found holding tadpoles, the others ranging from 14 to 25° C.

TEMPERATURES AND DIURNAL ACTIVITY

Data presented in Figure 1 were obtained from toads and their environment at elevations of 10,500 to 11,200 ft. in the Humphrey Basin-Pine Creek Pass area of Fresno County and 9,500 to 10,500 ft. in the Elizabeth Lake-Tioga Pass areas of Yosemite National Park. Most of the data wered obtained during August and early September in sunny weather and mostly between the hours of 10 A.M. and 3:30 P.M. A few temperatures, including the two highest body temperatures, are taken from Mullally (1953).

Figure 1 demonstrates the large range of body temperature present in active toads. Animals were found voluntarily outside of burrows with body temperatures of 8.2° to 30.6° C. Eliminating the two lowest readings, which represent some degree of emergence, the lowest temperature is then 13.6° C. The minimum temperatures for activity are not known but are suspected to be lower than the above data indicate. At the other extreme, only two animals have been found with body temperatures over 30° C., these being 30.4° C. and 30.6° C. Thermal conditions sufficiently

warm to create these and much higher body values have often been noted and are, in fact, the rule at mid-day. The toads, however, seem to have an aversion for such high body temperatures. Maximum voluntarily tolerated body temperatures are usually 28-30° C.

It has been our experience that during warm weather the most common range of body temperature for active toads is about 19-25° C. There may be some preference by the toads for this range, but if so, it certainly is not strong. Body temperature is dependent upon and derived from the available heat of the environment. The habitat of an animal usually provides a variety of local temperatures dependent upon the moisture, exposure, substrate, terrain, shelter and degree of vegetative cover. As a result, it has been found that even animals close together at any one time have a wide range of body temperature. In Figure 1, body temperatures which are close together were not necessarily recorded at the same time. In one instance, toads within several feet of each other had body temperatures ranging from 18.4° to 29.6° C. A few inches of movement by the toads to similar thermal positions could have resulted in greater uniformity, but such was not the case. This voluntary tolerance to a large range of body temperature and lack of strong preference for a limited one is in strong contrast to the situation prevailing in many species of reptiles studied by Cowles and Bogert (1944) and Bogert (1949). They noted that by habits and choice of microclimate, many reptiles regulate their body temperatures within a range of several degrees or less. Bogert (1952), however, showed that certain eastern salamanders exhibited no detectable thermal preference zone. A large thermal activity range has also been noted for *Hyla regilla* (Cunningham and Mullally, MS).

DESICCATION AND CHOICE OF HABITAT

Upon dry soil during mid-day at high elevations, intense solar radiation regularly produces surface temperatures of at least 55°-65° C., temperatures far too high for the toads to long endure exposure to them. This heating, in conjunction with the thin, dry atmosphere of high elevations, greatly augments evaporation from organisms and soil. Being diurnal in habits, if the animals occur in such an environment, they cannot easily avert the above conditions. Also, the surprisingly high body temperatures voluntarily tolerated by this high boreal denizen cause the species to be all the more susceptible to over-heating and desiccation.

On August 30, 1955 (near Tioga Pass in Yosemite National Park), several toads were noted in hot, dry meadows where the surface temperature was about 60° C. The meadow was level, with scattered tufts of low grasses, and pocked with the burrows of *Thomomys* and *Microtus*. Seconds after being frightened by human approach, the toads entered nearby burrows and usually escaped capture. Most of their time was spent underground. It was never determined if the toads lived here permanently or blundered into the area from more favorable surroundings during cooler portions of the day. Surprisingly, three animals captured on the surface had body temperatures of only 22.2° an 26.4° C., values much lower than others obtained from toads occurring in vegetation along the margins of nearby ponds. These toads mainly gained their low temperatures by their subterranean behavior.

The threats of high temperature, desiccation and greatly curtailed surface activity in their hot, dry microclimate seem to be the principal reasons for the toads being fairly restricted to the margins of streams, ponds and lakes. They are commonest within several feet of water, and usually occur within several yards of thick grasses, sedges and willows. However, if the soil surface is very moist and vegetation luxuriant, animals may occur many yards from water. Many adults and young have been noted on steeply sloping mountainsides in richly vegetated, moist meadows with only very small streams originating from springs. In such cases, the breeding waters are hundreds of yards distant. One such area is on the northwest slope of Mount Dana next to Tioga Pass. This local distribution correlates with the observation that Yosemite toads are only occasionally seen within water, even though they are constantly beside it. Perhaps the moist burrows supply moisture, and it may be unnecessary for the toads to be frequently immersed. However, when frightened while on banks, the toads readily resort to the water.

SOURCES OF HEATING

All terrestrial ectothermic animals active diurnally derive their heat from the air, substrate, insolation or combination of these. Body heat is derived from the microclimate or the climate prevailing at the site of and impinging directly upon the animal. It constantly varies over an area, and, in conjunction with the individual habits of the toads and lack of a strict temperature preference, it is responsible for the wide range of body temperature even among animals occurring close together. The values of the exact thermal microclimate are very difficult to determine. They include the temperature of the exact surface of the substrate, of irregularities on the surface and its plant covering, of all air layers up to the maximum height of the animal, determination of the potential heating effect by insolation, and heat loss and gain at any one moment to and from other parts of the environment by radiation and conduction. Many of these determinations are difficult to make and require very elaborate apparatus. For convenience and because of technical difficulties, the environmental temperatures described in the section on methods were chosen for recording. They seem to illustrate most of the major environmental sources of heating and cooling for the toads. Though certain unrecorded thermal factors may at times be responsible for several degrees of body temperature, the greatest one not taken into account is insolation. Toads in sunny areas are undoubtedly greatly influenced thermally by direct insolation. It is probable that insolation is the most important source of heat for basking animals.

Likewise, due to lack of necessary instruments, total appreciation of the effect of evaporative cooling is missing. It would be desirable to add relative humidities to the graph as an additional thermal factor. So long as the toads are exposed to the air, the effect of evaporative cooling is always present to some degree. The effect would be most noticeable when body temperatures are highest. This is due to the greatly increased rate of evaporation with rise of temperature. The ultimate result of evaporative cooling is to hold body temperatures an undetermined number of degrees below what would be attained otherwise from the immediate

environment. Inspection of Figure 1 indicates that the toads usually closely match surrounding environmental temperatures, not being cooled more than a few degrees by evaporation. Toads on land typically have a dry skin which seems quite capable of being rapidly warmed by insolation and contact with warm air or substrate. Even under rather cool conditions, they are able to warm well by basking.

Figure 1 shows that several parts of the thermal environment have little similarity to body temperature. One of these is the previously noted temperature of the dry soil surface under direct insolation at mid-day during warm weather. Another is the temperature of the air at a height of 5 feet. In sunny areas at mid-day the latter is lower than parts of the environment at much lesser heights which directly affect the animals. In the morning, the surface of shaded soil is cooler than the faster-warming air. The reverse is usually true late in the afternoon when the temperature of the air drops faster than that of the slowly cooling, warmed soil. The air at a height of 5 feet does not directly impinge upon the animals and is most important as an influence upon the lower few inches of air within which the toads occur.

One part of the environment which closely approximates the toads in temperature is the substrate surface upon which the animals have remained sufficiently long for thermal equilibrium to have become established. Such is the case especially when the animals are in shaded positions, in other words, when direct insolation is at a minimum. Naturally, due to the slanting rays of the sun, proportionally increasing shaded-over sunny areas, such conditions are most commonly met during early morning and late afternoon. Also, during early and late hours the sun heats much less than at mid-day, again proportionally increasing the thermal effect of the substrate upon the animals. The environment affords all degrees of shading for the animals, so they do not sharply fall into two groups according to exposure. Animals in intermediate positions are common at all times and perhaps predominate at mid-day in vegetated areas where filtered sunshine is the rule. However, the lower body temperatures in Figure 1 represent mainly the effect of shading and, at most, feeble insolation. Under these conditions temperatures of animals and soil surface are quite close. This relationship holds up to body temperatures of about 18-23° C. Presumably the correspondence continues up to higher body temperatures when warmer soil and air prevail in the shade. At high elevations, though, the shade is usually cool. Notable exceptions to the thermal proximity of body and soil surface are probably due to the toads having rested in the hot sunshine or upon substrate of different temperature just previous to having been found. They had not had time to equilibrate to the last thermal environment.

At mid-day, in warm clear summer weather, it has been found that body temperatures in excess of about 18-23° C. are usually the result of direct radiant energy upon the habitat. The highly heated soil surface and its overlying layer of air no higher than several mm., as well as insolation on the animals, promote the increase. Body temperatures diverge from the values of the originally most influential shaded and cool substrate and approach that of the moist insolated soil surface. However, the temperatures of animals usually fall between the values of shaded and insolated moist soil, and this is probably due to the partial

shading provided by vegetation and irregularities of the ground surface. At times moist soil warms more than Figure 1 indicates, 35°-40° C. not being uncommon. The toads must actively avoid prolonged exposure to these temperatures the same as on warmer dry soils.

There is confusion over whether toads in sunny situations are obtaining more of their heat from the soil or through insolation. Under conditions of shade, the toads closely approximate in temperature the surface of very moist soil and would presumably continue to do so on shaded soil as warm as though under insolation, or about 20-35° C. However, if the surface is sufficiently cool so that the toads need not actively seek cooler sites, even in the sunshine exposed toads are not more than a few degrees warmer than the surface. In fact, most animals choose some cover and have body temperatures close to or below the value of very moist, insolated soil. This seemingly slight influence of the sun may be due to an equivalent heating of both the soil at thermometer depth and the toads. Certainly both have a high water content and thus a few possibly comparable heating qualities. Also, both are continually cooled by evaporation.

Temperatures indicate that insolation does not much heat the toads. However, temperatures may be misleading. Actually, much heat may result, but this may be rapidly dissipated by radiation and conduction to the air and soil especially after the animals have returned from a brief excursion in the sun and have returned to the cooler shade. During the cooler portions of the day or year, the few extra degrees it is possible to gain by basking may be of great activity value.

Another element of the environment which seems to have a controlling influence upon the body temperature of the toads is the air layer at a height of ½ to 1 inch. As is not the case with the air at a height of 5 ft., the toads are found within this lower layer and are directly affected by it. Of course, they occur within and are affected by other layers of air lying between the substrate surface and the height of the animals. On insolated soil the gradiant of air temperature from the surface to a height of even 1 inch is very great (Geiger, 1944). Thus a broad range of air temperatures prevail at the site of a toad. Within the body of an ectothermic animal, a blending of many losses and gains of heat to and from parts of the microclimate must occur. Mullally (1952) has shown a demonstrable difference in deep cloacal temperature of *Bufo boreas halophilus* depending upon whether the thermometer is nearer the dorsal or ventral surface of the toad.

When body temperatures are low during warm weather because of shading or weak insolation, the air at a height of ½ to 1 inch is usually warmer than the toads by several degrees. These conditions are indicated in Figure 1 by body temperatures up to about 20° C., which are accompanied by nearly identical or slightly higher air temperatures at 1 inch. The toads are comparatively cool because of the strong influence of a cold substrate which warms slowly (especially if moist as it usually is near the toads). Presumably an exception to this relationship occurs in late afternoon when toads remain on soil heated by mid-day sunshine. At such times, air temperatures usually fall faster, especially if the weather is windy, than that of the soil surface. As a result the soil, and probably the toads also, are left comparatively warm.

During periods of intense insolation but unusually low air temperature, body temperatures are maintained considerably higher than the value of the air at 1 inch. To some degree, such conditions were once encountered and the results composed the part of Figure 1 having both low body and air temperatures. During these times body heat was derived from the warm substrate and solar radiation, for the animals appeared to be basking. Presumably, a far greater hiatus results if air temperatures are even lower. The writers (MS) have found another anuran of these same high elevations, *Rana boyli sierrae,* basking with body temperatures up to 25.5° C., when the general air temperature fluctuated between 4° and 6° C.

When the toads have body temperatures of over 20 to 30° C., depending upon the local situation, the air at a height of 1 inch is usually cooler than this. The higher environmental and body temperatures, the higher the point at which this divergence occurs. Exceptions to this generality are created when the animals find themselves in unusually cool situations. As previously noted, at mid-day insolated soil surfaces are generally too hot for the toads. The cooler air no doubt aids the animals in maintaining tolerably low body temperatures, but additional aids include integumentary evaporation, cool sites on irregulr ground, and shading clumps of vegetation. A factor which tends to complicate the situation and which cannot be neglected is the air layer immediately adjacent to the substrate surface. This layer is nearly as highly heated as the soil itself, and, in contrast to the layer at 1 inch, it raises body temperature. Considering the effect of direct insolation, heated soil, and the lowest air mass, it is little wonder that toads retreat to shade.

SUMMARY

1. Though the Yosemite toad is predominantly diurnal, a few toads have been found out of burrows under crepuscular conditions. Reduced illumination rather than low temperature is mainly responsible for lack of evening activity.

2. The diurnal habit is probably the main factor that enables the species to be active during the cool earliest and latest weeks of activity and during the unusually cold weather of the warmer months.

3. The toads are confronted by a low temperature problem when emerging in the morning. Emergence has been noted at a body temperature of 8.2° C. Some evidence indicates that the toads emerge toward sunlight when the temperature of body and soil are much lower, perhaps 2-3° C.

4. During cool weather Yosemite toads bask in sunlight to absorb heat. Basking animals usually have body temperatures under about 18° C.

5. Even during the summer months tadpoles are subjected to water temperatures as low as 8° C. on cold nights.

6. The body temperature of active animals ranges between at least 8.2° C. and 30.6° C. While the highest recorded body temperature is 30.6° C., the usual maximum voluntarily tolerated body temperature is 28-30° C. The most frequent range of body temperature for toads active during mid-day in warm weather is 19-25° C.

7. There seems to be no strong preference for any particular body tem-

perature, and the range between toads only a few feet apart under a varying microclimate may span many degrees.

8. Though normally occurring near water and in moist meadows a few are found in dry meadows. Here they spend much time in rodent burrows and remain cooler than animals close to water.

9. An effort is made to determine the sources of heating and cooling in the animals' environment. The temperature of the air at a height of 5 feet has little relation to body temperature. At mid-day in warm weather, dry soil under direct insolation is far too warm for the toads. Available data indicate that the temperature of the substrate has the strongest influence upon body temperature. The air temperature at a height of ½-1 inch is also influential. Whenever animals occur in sunshine, insolation is an important source of heat. It is particularly so during cool weather when toads bask.

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Thermal Factors in the Ecology of the Pacific Treefrog

By JOHN D. CUNNINGHAM and DON P. MULLALLY

Temperature relations are of paramount importance to the complete ecological understanding of any animal species, especially of the ectotherms. "Cold-blooded" animals can be active only within ranges of environmentally induced body temperatures to which they are specifically adapted. Body temperatures beyond the limits of the activity range mark the critical limits at which incapacitation or death results (Cowles and Bogert, 1944). Favorable temperatures must prevail for a certain minimum length of time or the species fail to survive because of starvation or insufficient time for completion of the life cycle. Many animals are limited in distribution by thermal factors just as surely as by scarcity of food and cover or the presence of unfavorable substratum. Some species are more stenothermic than are others. Because of the extensive latitudinal range of *Hyla regilla* Baird and Girard, it is natural to expect the existence of unusual thermal tolerances. Various aspects of the thermal relations of *Hyla regilla* form the subject matter of this paper.

To Dr. Raymond B. Cowles of the University of California at Los Angeles we would like to express our thanks for a critical reading of the manuscript. To the Womens' Auxiliary of the San Mateo Junior Museum are due thanks for aid in typing the manuscript.

LOW TEMPERATURE RELATIONS

At several times and places treefrogs have been observed under climatic conditions sufficiently cold to establish with fair certainty the minimum temperatures under which the species is normally active. In order to obtain reliable data on this thermal facet it is necessary that the observations be made at times when the weather is such that the animals first have been exposed to temperatures allowing "normal" activity which are followed by succeedingly colder conditions until below minimum environmental levels have been reached. Under any other set of conditions it is difficult to determine actual minimal temperatures. Discrepancies between our data and those of Brattstrom and Warren (1955) are probably due to more extended observations under the above conditions by the writers.

One effective period of observation was obtained on February 11, 1955, in the Richfield Oil Corporation's South Cuyama Oil Fields in Cuyama Valley, Santa Barbara County, California, at an elevation of approximately 2,000 feet. Shortly after sundown a population of an estimated 45 *Hyla* was engaged in breeding activities in a short segment of a slowly-flowing creek several feet wide but only a few inches deep. The male chorus was very loud. The water at this time was relatively warm (9.5°-11.8° C.) from day time heating, but the temperature dropped throughout the evening. Many amplexing pairs were found on the surface of the water, clinging to the bank or to water plants. No eggs were discovered in the stream but dissection of several of the females found in amplexus revealed eggs ready for laying. The only other species of

amphibian in this area was the western toad, *Bufo boreas halophilus* Baird and Girard.

Under nocturnal conditions it was found that the temperature of the water immediately surrounding a *Hyla* approximated its cloacal temperature within 0.1° C., the two temperatures in almost every case being identical. The air temperature seems to exert little influence on the cloacal temperature of submerged *Hyla,* even though in most cases their heads were at least partially exposed to the air. Being thus exposed to the cold air, head temperatures could conceivably have been considerably lower than either the recorded cloacal or water temperatures indicate. Mullally (1952) has shown that in *Bufo boreas halophilus* there is a significant difference in deep cloacal temperature depending upon whether the readings are made near the dorsal or ventral surface of the animal; the dorsal surface was affected by the air temperature while the ventral surface was more affected by the substrate temperature. Failure to detect any evaporative cooling in the *Hyla* may have been due to high relative humidity immediately above the water surface. Because of the close identity of water and cloacal temperatures, the procedure for taking most subsequent temperatures of *Hyla* submerged in water (but known certainly to have not just entered the water) was simply to record the temperature of the surrounding water at depths determined by the degree of submergence and always within an inch of the *Hyla.* Not only was this procedure found to greatly hasten work and not excessively to disturb the animals, but it was also necessary for accuracy due to the large thermal gradient between the human hand and the cold *Hyla.* In a small animal the rapid temperature increment resulting from handling leads to erroneous data. Despite the fact that the minimum temperatures recorded hereafter were taken in this manner, i.e., of water in close approximation to the *Hyla,* and no true cloacal temperatures were taken below 8.2° C., the cloacal temperatures of the *Hyla* presumably could have been no higher than those of the water in which they were submerged. The air temperatures were in every case considerably lower than those of the water, in many cases being below 0° C. Measurable metabolic heat can be excluded from consideration with such small animals because of the heat conductivity of the water and lack of insulation. All of the temperatures recorded were taken with a small, quick-registering Schultheis mercury thermometer.

The male chorus was louder at this time than at lower temperatures observed later. However, no abrupt change in breeding behavior was to be noted at any lower temperature level. Rather, with a drop of environmental temperatures there was a gradual tapering-off of chorusing and activity in general. Apparently this was due to lessened activity of all animals combined with cessation of singing by individual males as their body temperature dropped. It was noted with several male *Hyla* that with lowered body temperature their song notes diminished in frequency, but that there was little or no detectable alteration of pitch and loudness. Possibly the frequency of the song note varies within limits directly with the temperature as has been shown, for example, in *Acris crepitans* Baird (Jackson, 1952).

A strong chorus continued down to a water temperature of 7° C. and an air temperature at a height of 1 inch above the water of 5.5° C. The

hylas were submerged with only their heads and sometimes the upper surfaces of their backs protruding above the water. In water of less than 7° C. the chorus was noticeably diminished. Fewer males sang as the temperature continued to drop and the last male was observed at 2 a.m. singing in 3.8° C. water. The air temperature at a height of 1 inch above the water was approximately -4° C. Later that night the air temperature dropped to about -5° C. and a thin film of ice covered sections of the creek the following morning. Intermittent croaking continued throughout the night until just before sunrise. The *Hyla* which early in the evening had been sitting in the shallow margins of the creek had gradually moved into deeper pools later in the evening. Apparently hylas submerged when body temperatures dropped below approximately 4° C. Elsewhere, in the morning following subfreezing nights, *Hyla* have been noted several inches beneath the surface hanging onto stalks of submerged vegetation or clinging to objects resting on the bottom.

To determine if at higher elevations male *Hyla* had acclimated to chorus at even lower body temperatures, the writers, on April 2, 1955, observed *Hyla* at Big Bear Lake, San Bernardino Mountains and County, California (6750 feet). Strong winds causing waves on the lake and large ripples on adjacent ponds prevailed at this time with the air temperature at 7 p.m. being -0.2° C. Large areas of damp soil were frozen to about ½ inch depth. Many *Hyla* were croaking from a pond near the lake in 5.6° to 10.2° C. water. By 7:30 p.m. the air was -2° C., frost was more widespread and many of the smaller ponds had completely frozen over. Some *Hyla* were noted in the cold, shallow margins even though warmer water was available several feet out in the same pond.

At 8:30 p.m. in a pond which normally harbors a large population of breeding *Hyla*, only a single male was calling. This male was clinging to grasses protruding from shallow water approximately 10 feet from the shore. The temperature of the water immediately next to this singing male was 4.0° C. and that of the air immediately above the water was approximately -2° C. A gravid female was discovered sitting on damp soil about 4 inches below the surface of the ground in a rodent burrow under a board approximately 15 feet from the pond. The animal's body temperature and the temperature of the soil upon which it was sitting was 3.2° C. and the air temperature was below -2° C. Strong winds were still blowing and all moist soil on the surface was now frozen to a depth of over 1 inch.

By 9:00 p.m. the environmental temperatures at the first noted location had dropped so low that no *Hyla* were active. At the pond where a male had previously been calling in 6.0° C. water, the water temperature near the surface had dropped to 3.2° C. and no *Hyla* could be found.

From these data it appears probable that breeding populations at moderately high elevations are no more cold adapted than are those in lower and warmer climates. It is probable that the two populations cited were essentially identical in their responses to low temperatures and that the lower relative humidity and strong wind at Big Bear Lake were responsible for the seemingly slight difference. Workers at even higher elevations, especially near the species' upper altitudinal limit, should further test this point, however. In both locations the minimum water temperatures from which male *Hyla* will call appears to approximate 4°

C. This is considerably lower than the lower limit for such behavior stated by Brattstrom and Warren (1955) and it is interesting to note that the lower limit for chorusing of 3.8° C. found by the writers was at the exact location and time of year that those authors became "convinced" that male *Hyla regilla* "do not (or cannot) sing below 9.8° C. . . ."

At the height of the breeding season the males commonly call during the day. In the situation of rising temperatures during a morning following a night when water temperatures dropped to freezing or near-freezing, it is not known whether male hylas will begin to call when the water temperatures reach about 4° C. or whether they wait until a higher thermal level is reached.

The actual effect of the male's call, if any, in enticing the females from their terrestrial retreats to the water is unknown. To the writer's knowledge it has not been definitely determined that a female *Hyla regilla* can detect the call of the male through the air. However, it is felt by the writers that calling by the males at low temperatures is not entirely fruitless. While it is true that with air temperatures below 0° C. a female has little chance of making her way to the water from her diurnal retreat without first becoming torpid or even freezing, those females already in the water are able, according to Brattstrom and Warren (1955), to detect the male's call. This was suggested by finding amplexing *Hyla* in water as low as 8.0° C. Possibly, however, the chorusing has an effect on the male breeding population somewhat analogous to the complex behaviorisms of the prairie chicken and related gallinaceous birds, that is, to stimulate all males in the breeding population to sexual activity simultaneously. In this way the females, which normally enter the water singly or at most in small groups, would be insured fertilization by one of the first males encountered.

Responses of *Hyla* to low temperatures indicate considerable individual variation. It is to be emphasized that although certain individual male *Hyla* will call from water as low as 3.8° C., the majority do not. Most males at Cuyama Valley ceased calling when the water reached 7° C. The pools from which the minimum temperature data were obtained at Big Bear Lake were procured from a relatively few individuals. These pools normally harbor many hundreds of individuals when the environmental temperatures are higher. Whether breeding activities associated with calling, such as amplexus, egg laying, etc., are also present down to temperatures as low as 4° C. is unknown. The lowest temperature at which *Hyla* were observed in amplexus was 8.0° C. at Cuyama Valley and 8.1° C. at Lake Sherwood, Ventura County, California (2000 feet). However, quiet pairs at even lower temperatures might easily have escaped detection.

While eggs have been found in water of various temperatures, the actual temperature conditions prevailing at the time the eggs were deposited is not known to us. Amplexus and spawning may last for many hours (Smith, 1940) and pairs may even be found in amplexus at midday, as they were at Lake Sherwood in February. Water temperatures fluctuate greatly from day to night. Quiet, shallow water, isolated or protected from circulation, at high elevations, such as at Big Bear Lake, fluctuate from near freezing at night to 20°-30° C. in the early afternoon,

and eggs are usually laid in shallow water. That the eggs of *Hyla regilla* are able to endure occasional freezing has been shown by Schechtman and Olson (1941). They found that eggs in the neurula and gastrula stages developed normally when thawed after being kept overnight in a refrigerator compartment of -5° to -7° C., even though they had become embedded in solid ice. Eggs representing all stages through the tail bud which had been stored for up to 8 days at 4°-5° C. developed normally when brought to room temperatures. It is extremely difficult to determine the temperature conditions under which oviposition and insemination occur unless the spawning process proceeds under continuous observation. It seems hardly conceivable that *H. regilla,* with its wide thermal plasticity in other regards, lays its eggs only in water within the narrow range of 12°-15° C. as reported by Brattstrom and Warren (1955), when these eggs, after they are laid, can withstand a temperature range of over 40° C. The writers have found recently laid eggs in streams where the lowest water temperatures were above 20° C.

It was previously noted that during subfreezing weather a *Hyla* was found in a subterranean retreat. Because of the propensity of hylas for concealment in burrows, it is probable that many more escaped detection in similar situations. At 11:00 a.m. on February 20, 1955, near Lake Sherwood, many *Hyla* were found several inches below the surface in burrows beneath rocks and in leaf litter under logs. At this time frost covered the ground in shaded locations. *Hyla* in such situations were found as far as 300 yards from the water. Cloacal tempertures of such inactive *Hyla* registered 3.4° to 6.5° C. At the same time other *Hyla* were calling and amplexing in the nearby creek. Eggs were present in water of 8.1° to 14.5° C.

From 10:15 to 10:45 a.m. on February 11, 1955, near a small lake off Highway 399, 3 miles north of Casitas Springs, Ventura County, California, a large number of *Hyla* was found in burrows and in cracks of the soil and under surface objects of every sort. Commonly as many as 10 hylas would be crowded into a single small depression. Chorusing was in progress and most of this was by males actually concealed in moist burrows. The only females observed were in amplexus in 8.9° to 9.7° C. water. All of the females contained large eggs ready for deposition. The previous night had been cool and relatively few of the *Hyla* were active out of their retreats. Those that were active were sitting on the banks near the water or in amplexus.

The species also retreats to subterranean shelter in hot weather. During a warm afternoon in May near Manhattan Beach, Los Angeles County, California, 17 young and adult *Hyla* were found 10 feet from the water in a single moist burrow running to 20 inches below the surface. Along the Mojave River near Victorville, San Bernardino County, California, the species is commonly found in burrows and under surface objects during the warm days.

REFRIGERATION EXPERIMENTS

Knowing that *Hyla regilla* are normally active down to about 4° C., the writers were curious as to the animals' locomotory abilities and tolerances at even lower temperatures. Several *Hyla* were captured in a creek of 11°-13° C. in the Los Angeles area and their responses to low temperatures were observed in a refrigerator.

Under laboratory conditions in water of 1.0° C., treefrogs were able to swim slowly but in a coordinated manner on the surface and to rise and submerge nearly vertically, but with some difficulty, a distance of at least 9 inches (the greatest depth of their container). Submerged frogs occasionally rose to the surface, perhaps for air. Animals in water of 0.2° C., which was covered with a thin film of ice, were able to swim horizontally very slowly with typical swimming motions but were limited in endurance and vigor. One such animal made 18 swimming "kicks" with the rear legs in 30 seconds. Four *Hyla* were left in near-freezing water for 13 hours, at which time a 1/8 inch layer of ice covered the top. One *Hyla* had the tips of its toes on one of the fore legs frozen in the ice. It occasionally kicked with its hind limbs and attempted to free itself by "pushing" movements against the layer of ice with its free front leg. The remaining *Hyla* were able to swim slowly and to right themselves if placed on their backs. Thus *Hyla regilla* has fair powers of locomotion in near-freezing water, perhaps power enough to escape from occasional dangerous cold in nature. It seems certain from the above experiments that even in a pond completely frozen over a *Hyla* could easily submerge and bury itself in the bottom debris or mud.

However, on land at similar body temperatures the animals are much more feeble. With body temperatures under about 2° C., reduced coordination plus adhesion of moist, sticky bodies against the substratum are usually sufficient to neutralize the propelling force of the hind legs. The animals go through the motions of leaping but move forward only slightly. Obviously, in cold weather the surface of the soil is a dangerous environment for a *Hyla*. That the hylas are generally successful in finding retreat from dangerously low temperatures is evidenced by the fact that no frozen *Hyla* have ever been found in nature by the writers.

On several occasions captive *Hyla*, both in the field and in a refrigerator, have failed to freeze and have survived at least 8 hours exposure to temperatures of −0.5° to −1.0° C. Such animals have even become encrusted with ice crystals without apparent permanent injury. During one laboratory experiment 4 *Hyla regilla* were frozen rigidly for 6 hours at a temperature of -2° C. After being thawed for a period of one hour, 2 of the animals recovered. At high elevations such as at Holcolm Valley (7400 feet) near Big Bear Lake or at String Meadow (9800 feet) in the Sierra Nevada Mountains, Fresno County, California, where even midsummer, nighttime temperatures are frequently below freezing, the writers have found *Hyla* early in the morning under surface objects or in shallow rodent burrows with frost on their backs and sitting on frozen soil. Both *Bufo boreas halophilus* and *Bufo canorus* Camp have been found in such retreats with *Hyla* at various locations.

In the light of the above data it is easier to understand several instances of seemingly unusual activities of *Hyla regilla* recorded in the literature. For example, Grinnell and Storer (1924) describe the chorusing of *H. regilla* on a February 28 in Yosemite Valley (4000 feet), California, when two feet of snow surrounded the inhabited waters. They also heard chorusing under deep snow banks on Mount Hoffman and in a lake almost completely covered with ice at an elevation of 10,600 feet. Grinnell, Dixon and Linsdale (1930) describe the emergence of *Hyla* following the partial melting of a fall snow.

HIGH TEMPERATURE RELATIONS

Adaptation of *H. regilla* to low temperature has been commented upon. An equally important aspect of the ecology of this frequent dweller of oases in the desert and streams in semi-arid areas is its tolerance to high temperatures.

On August 15 and 16, 1952, *Hyla* were noted in ponds and tarns near Tioga Pass in Yosemite National Park. Although more numerous among lodgepole pines at an elevation of about 9500 feet, many were also present about a mixture of whitebark pine (*Pinus albicaulis*) and lodgepole pine (*Pinus contorta latifolia*) near the crest of the pass at an elevation of 9900 feet. At sundown a chorus of hylas began. Young were noted, varying from small legless tadpoles up to recently metamorphosed frogs carrying remnants of larval tails. At midday *H. regilla* tadpoles were found concentrated in water only a few inches deep along the margins of the ponds and in marshes extending out many feet. Instead of deserting shallow water at sundown for deeper water as did the tadpoles of *Bufo canorus* and *Rana boyli sierrae* Camp, the tadpoles of *Hyla regilla* remained in the marshes and concealed themselves beneath bottom debris and mud.

Within such shallow marshy areas *Hyla* tadpoles were found in water reaching high diurnal temperatures. Early in the afternoon, water of 1 to 3 inches deep registered 30°-34.4° C., with the shallows having the highest temperature. Tadpoles were present in water of up to 34.0° C. Finding tadpoles at 34.0° C. surpasses the 33.4° C. at which Brues (1932) found specimens at Paraiso Hot Springs, California. At elevations between sea level and 4000 feet on the coastal slope of southern California, tadpoles have been found in water of up to 33° C. on several occasions by the writers. Apparently water temperatures of 33°-34° C., or possibly even higher, are quite acceptable to larval *H. regilla* and constitute a common incident in its life. It is notable that slightly higher water temperatures have been encountered at nearly 10,000 feet than at much lower elevations. If this is a common occurrence, then it is possible for some amphibians living at high elevations to be adapted to high water temperatures as well as or better than are those living at lower and supposedly warmer elevations. Along coastal canyons of the Pacific Coast, hylas are very common wherever water is present during at least part of the spring. There they are commonly subjected to low clouds or fog for long periods and the water temperatures seldom attain high levels. In such coastal canyons in the Santa Monica Mountains, the writers have found small tadpoles in mid-September. These tadpoles do not metamorphose until at least early October. Following the longest and most severe heat wave in the history of southern California in early September, 1955, the highest water temperature found in one of the above mentioned canyons was only 26.4° C. At Point Lobos near Monterey, California, another region where summer fog and low clouds are common, Grinnell and Linsdale (1936) found tadpoles in cool water and recently metamorphosed young as late as November 10.

Schechtman and Olson (1941) found that the eggs of *Hyla regilla*, in various stages of development, had an unusually high temperature tolerance for an amphibian. All stages developed normally in water of up

to 33° C. A few deaths and abnormalities occurred within 34° C. In water temperatures of 35°-38° C. a decreasing number of eggs developed to maturity without abnormalities. Water of 39° C. was found to be fatal to all developmental stages.

A few preliminary experiments have been conducted to determine the critical maximum temperature (Cowles and Bogert, 1944) of adult *H. regilla*. In one test 4 *Hyla* which had been captured in water of 12.0° C. in the Los Angeles area were acclimated for 27 hours at a temperature of 29° C. At that temperature the animals were unusually light colored and quick in their actions. The *Hyla* were placed in a small chamber with ½ inch of water in the bottom. Ventilation was provided and the relative humidity was in effect 100%. All *Hyla* survived 2 hours exposure to 34.5° C. Subsequently, over a period of 30 minutes, the temperature was raised to 36.0° C. At the end of that time the next to the largest animal became uncoordinated, that is, reached its critical maximum, but recovered upon removal from the chamber. Thirty minutes later, at 36.5° C., the largest animal likewise reached its critical maximum. Fifty minutes later, at 37.2° C., the next to the smallest animal reached a similar state. Shortly thereafter the smallest animal was removed from the chamber in a healthy condition. This animal had consistently placed itself near to an air port, however, and may have cooled itself slightly by evaporation. In another test conducted in a temperature control room especially designed for physiological research, 3 out of 12 male *H. regilla* survived 30 minutes exposure to water temperatures of 37.3° C. and air temperatures of 37.7° C. In this test, however, the *Hyla* had not been acclimated as thoroughly as before, being subjected directly to 33° C. water from 24° C. water. The length of time that the *Hyla* are subjected to supra-normal temperatures is highly important. Possibly being subjected for a long period to temperatures of 33°-35° C. would be as fatal as a short exposure to water of above 37° C. The conditions under which Brattstrom and Warren (1955) determined the upper lethal for adults to be 38.1° C., or the previous thermal history of their two experimental animals, were not stated.

Under the conditions noted above, the maximum lethal temperatures of adult *H. regilla* is about 35°-38° C. Not all animals die at the same temperature, individual variation accounting for a range in the lethal of about 3° C. The ability of adult *Hyla* to tolerate these body temperatures seems almost inconsequential since the writers have not yet found adults at such high thermal levels. In the coastal area of southern California, the highest body temperature we have recorded is 24° C. On August 30, 1955, however, at an elevation of about 10,200 feet near Tioga Pass in Yosemite National Park, 2 adults were found at 2:30 p.m. with body temperatures of 26.4° and 27.2° C. These and several other animals of lower body temperature were noted in a moist meadow among grasses and other herbaceous, green plants. Under the partial shade of grass, the surface of moist soil registered 31°-33° C. and the air at a height of one inch was 24.5° C. Considerable searching yielded only a few adults and these were apparently made active only by the disturbance caused by the collector.

The relatively low body temperature usually held by adults during the day may be actively maintained by movement to cool sites or be the incidental result of other habits. This question is not here resolved. How-

ever, since the maximum lethal temperature is so high, it would seem strange if adults commonly shun temperatures in excess of 25° C. However, if they do, the species may not be well adapted to very warm climates, and, indeed, it is notable that *Hyla regilla* does not occur in the southeastern desert region of California. Some bodily mechanism may require low temperature, but if so it must develop after the tadpole and young-frog stages, as the following work will indicate. Perhaps prolonged exposure to temperatures in excess of 25° C. have a sterilizing effect on the treefrog's germ plasm. Cowles and Burleson (1945) have shown that in the night lizard, *Xantusia vigilis* Baird, exposure to moderate and somatically harmless heat produces sterility for at least the remainder of the season in which it occurs. To the writers' knowledge no comparable work has been done on anurans. It is only during the breeding season that large numbers of adults are found active during the daytime. After the breeding season the adult treefrogs generally retreat during the day to subterranean shelter or to secluded spots in vegetation or debris. Nocturnality and the above mentioned retreats preclude common exposure to high temperatures. Occasionally, however, adults in their daytime retreats are subjected to comparatively high temperatures and warm to at least 27.2° C. without apparent stress.

Recently metamorphosed *Hyla* present a much different pattern. During the summer and into early fall great numbers of these very small hylas (mostly 11-19 mm.) may be found among the mesic vegetation peripheral to the breeding waters. In such places they cling to the leaves and stems of short grasses and sedges or sit in the shade of any available vegetation. Few hylas are found in places where the vegetation is sparse or the soil is not damp. In ideal situations these young *Hyla* will be extremely common, a score or more in a square yard. When frightened the young hop in all directions, clinging with great dexterity to the vegetation. If the breeding season is over, adults are rarely found active in such situations.

Unlike the adults, the young are active in greatest numbers during the day. With such diurnal habits and the habitat preferences noted above, the young are inevitably exposed to higher environmental temperatures than are the adults. Body temperatures were secured from the young treefrogs by hastily entangling them in grass with as little hand-frog contact as possible. The bulb of a Schultheis thermometer was inserted orally. Comparaed to the size of the animal, the bulb of the thermometer is rather large, introducing a source of error since the instrument might change the temperature of the animal, as well as conversely. Holding the animals, even by the tips of their toes, removes them sufficiently from their original microenvironment to introduce another source of error. Thermocouples are essential for securing accurate data from such small animals but unfortunately none was available. Thus the data secured are probably accurate to only about 1° C.

One series of observations was made on August 30, 1955, at an elevation of 9900 feet near Tioga Pass, Yosemite National Park, California. Another series was made on September 2, 1955, at an elevation of about 500 feet at San Andreas reservoir near Millbrae, San Mateo County, California. Respectively, in these two localities, the air temperature at 1 inch height in grass was 27° C., 38° C.; moist soil surface in sun, 40.6° C.,

40.0° C.; moist soil surface in shade, 19-22° C., 21° C.; number of animals tested, 24, 19; extremes of body temperature, 21.4-31.0° C., 29.5-33.2° C.; mean body temperature 27.9° C., 31.6° C. (standard deviation, 2.11, 0.96; standard error of mean, 0.43, 0.22). The San Andreas results were made possible by the intense heat wave mentioned previously. In neither locality was much activity of young frogs noted during midday. Temperature conditions warm enough to heat the surface of the dry, insolated soil to 60° C. probably forced the animals to remain in at least partial shade. However, it is notable that only a few hylas chose the lowest body temperatures it was possible to obtain in the shaded, damp soil at the bases of numerous clumps of grass. They seemingly favored body temperatures in excess of 19°-20° C. Likewise, they avoided the highest available temperatures; the highest body temperature recorded at Tioga was 31.0° C. and at San Andreas was 33.2° C.

Mean and maximum body temperatures were highest at San Andreas. Also, variations from the mean body temperature were much less there. These results are commensurate with the highest environmental temperatures at San Andreas. The extreme heat at San Andreas served to heat nearly the entire population to a rather uniform high level. At this location the water and air was much warmer, and the area of cool, moist soil surfaces was reduced in relation to those at Tioga.

When disturbed from their retreats, the young would travel for several minutes over the heated grasses and soil without apparent injury. One such animal was noted to heat to 34.2° C. Only when frightened were any young ever seen to resort to jumping into the relatively cool water at Tioga (24°-26° C.) or the warm water at San Andreas (31.6°-33.2° C.). Fifty to 100 feet from the ponds at San Andreas a few young were noted beneath rocks on moist soil of 21.2° C. These cool sites, which exemplify where adults might also be expected, were further inhabited by young *Rana aurora draytoni* Baird and Girard and by *Taricha t. torosa* Rathke.

Along the Mojave River at the northern base of the San Bernardino Mountains (3000 feet) during the summer of 1955 it was found that early in the morning, in sections where recently metamorphosed hylas were extremely common later in the day, relatively few young were active. Temperatures at the time were well within their range of activity yet the young were found under surface objects along the stream. Only when the environmental temperatures reached about 20° C. were large numbers of treefrogs found active. The temperatures, in degrees centigrade, at which these young Hyla were found active at various times of day (DST) are as follows (the figure preceding the colon is the time; the first one after each colon is the temperature of damp soil in shade, the second the air temperature 1 inch above the surface): 0645: 20.2, 21.6; 0655: 19.8, 20.3; 1205: 25.2, 25.2; 1230: 34.6, 28.0; 1230: 29.3, 30.8; 1235: 28.9, 29.8; 1300: 37.6, 31.4; 1500: 26.9, 26.4; 1535: 23.6, 20.4; 1610: 24.4, 24.7; 1610: 27.0, 29.2. The temperature of the damp soil in the sun near the stream, and only a few inches away from where the hylas were active, ranged from 35°-55° C. Generally the temperature of the shallow, exposed stream ranged from 30°-39° C. in the afternoon. If hylas were frightened toward the water they generally "skittered" over the surface

to the shade on the damp soil of the opposite bank rather than hesitate in the warm water.

The young treefrogs, then, voluntarily tolerate remarkably high body temperatures in relation to what we now know about the temperature relations of amphibians. The only data available regarding the upper lethal limit of these young hylas stem from the following observation. During the work at San Andreas, a number of young *Hyla* were confined in a glass jar. Due to atmospheric heat, the temperature of the jar and its occupants rose quite rapidly. Few of the animals died from 20 minutes exposure to 36° C.; most, but not all, died when the temperature rose for about 15 minutes to 37.0°-37.5° C. According to these preliminary data, the upper lethal varies from slightly below 36° C. to perhaps 38° C., values in close approximation to those obtained more accurately for the adults.

Whereas the adults have relatively low eccritic temperatures, the young are active at thermal levels close to those at which tadpoles have been found. It is interesting to note that the relatively more thermophilic tadpoles and recently metamorphosed hylas voluntarily tolerate body temperatures within a few degrees of their upper lethal. The close approximation of the maximum temperatures tolerated and the critical maximum has been noted for certain desert reptiles by Cowles and Bogert (1944). The function of these near-critical body temperatures seems to be endurance of high environmental temperatures and thermally increased physiological efficiency.

SUMMARY

The study is mainly concerned with the high and low temperature relations of *Hyla regilla* in southern and central California. Both field and laboratory experiments and observations are included.

1. Pacific treefrogs at elevations of 2000 feet in Cuyama Valley and 6750 feet at Big Bear Lake, California, were found to have similar low temperature relations during the breeding season. Full chorusing progresses in water down to 7° C. At water temperatures below 7° C. fewer males continue to chorus. The lowest water temperatures from which males were found calling were 3.8° and 4.0° C.

2. Amplexing pairs of treefrogs have been found in water of 8.0° C. The temperature conditions prevailing at the time eggs are laid is not resolved.

3. Air temperatures were found to have little effect on the activities of breeding treefrogs. Breeding proceeds in sufficiently warm water even though air temperatures are below freezing.

4. Dangerously low temperatures are avoided by submerging to lower depths in water and by seeking subterranean retreats.

5. Slow swimming is possible in water of nearly 0° C. and beneath a surface film of ice. On land the animals are nearly helpless when body temperatures reach about 2° C. or lower.

6. Body fluids usually freeze at between -1° and -2° C., and death ensues. Temperatures above this point are safely endured for many hours.

7. At an elevation of 9900 feet in the Sierra Nevada Mountains, tad-

poles were observed active in shallow water of up to 34.0° C. Tadpoles are subjected to large daily temperature fluctuations.

8. Adult *Hyla* from the Los Angeles area reached their critical maximum upon short exposure to temperatures of 36°-37.7° C. A cursory observation indicates that recently metamorphosed hylas have a similar tolerance to high temperatures.

9. Except during the breeding season, adult *Hyla* are usually nocturnal and seclude themselves in cool retreats during the day. As a result, these animals are rarely found with body temperatures over 24° C. However, in warm meadows at high elevations adults have been noted with body temperatures of 27.2° C.

10. In the summer and fall, young hylas are active under diurnal conditions along the borders of the breeding waters. These animals have been noted, between elevations of 500 feet and 10,000 feet, with body temperatures of up to 34° C.

11. When confronted under diurnal conditions with both coolness (20° C.) and extreme heat (40°-60° C.), the young treefrogs regulate their body temperatures within an intermediate level of rather wide range by their habits and choice of microhabitat.

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DISTRIBUTION OF THE WOOD TURTLE, *CLEMMYS INSCULPTA*, IN MARYLAND.—The Wood Turtle has been found quite frequently in the four westernmost counties of Maryland, namely, Garrett, Allegany, Washington and Frederick. More eastern records for this turtle in Maryland are scattered. McCauley (in "Reptiles of Maryland," 1955: 155) cites specimens from along the Potomac River as far south as Cabin John and Plummers Island, in Montgomery County, Maryland. No doubt these specimens had come down the Potomac from the mountainous counties mentioned above. McCauley cites specimens from along the Susquehanna River at Havre de Grace; these presumably are also waifs carried down the Susquehanna from the mountainous regions of Pennsylvania where this turtle is more abundant. Specimens I have collected in the Broad Creek area in northern Harford County are of importance as a link between the Pennsylvania specimens and those found at Havre de Grace (USNM 14582) and on Roberts Island (cited in McCauley).

Between the Potomac and Susquehanna Rivers are several large rivers (Patapsco, Big Gunpowder, Little Gunpowder, Broad Creek) coming down from the Piedmont area to the Chesapeake Bay. Three records from near these rivers are available in Baltimore County: south of Liberty Dam on the Patapsco River (one specimen, C. F. Reed); Notch Cliff Road at the Big Gunpowder River (one specimen, C. F. Reed, June 15, 1955); and White Marsh, a locality just east of and below the Fall Line and just south of the Big Gunpowder River (Surface) 1908). From these records it seems likely that the Wood Turtle gets down most of the large mountainous and Piedmont rivers in Maryland as far as the Coastal Plain.

The record from White Marsh reported by Surface is somewhat discounted by McCauley on the basis that the specimen was seen in the water eating the flower buds of water lilies in ponds. Due to the more terrestrial habits assigned to this turtle, alluded by the name "Wood Turtle," McCauley leaves the matter obscured by stating that the specimen was probably not the Wood Turtle, and that the description of the specimen was too indefinite to refer to any other turtle with certainty.

From my own experience in collecting the Wood Turtle in Maryland, I have invariably found it in or very near water. In Allegany County I collected this turtle swimming in Fifteen Mile Creek; in Frederick County, in the Catoctin Mountains, I collected it in a spring; in Baltimore County it was very near the Big Gunpowder River (about 20 feet away), and at Liberty Dam it was along the Patapsco River. I have never found the Wood Turtle in what I would call a truly terrestrial habitat, that is, in a woods.

One other record for the Wood Turtle in Maryland seems very interesting. It is a record from the Eastern Shore, from near Easton in Talbot County. This specimen was collected at night crossing the road (see McCauley, *loc. cit.*). Again, McCauley questionably discounts the specimen as a probable escape in that region. However, the region about Easton, Wye Mills and Longwoods in Talbot County is a very interesting one from an ecological point of view. Many plants are known off the Piedmont Plateau only in this one Coastal region of the Eastern Shore. From the number of Piedmont species of plants which I have found in this region, I am sure that the Wood Turtle and perhaps other animals are here because of natural distribution.—Clyde F. Reed, 10105 Harford Road, Baltimore 34, Maryland.